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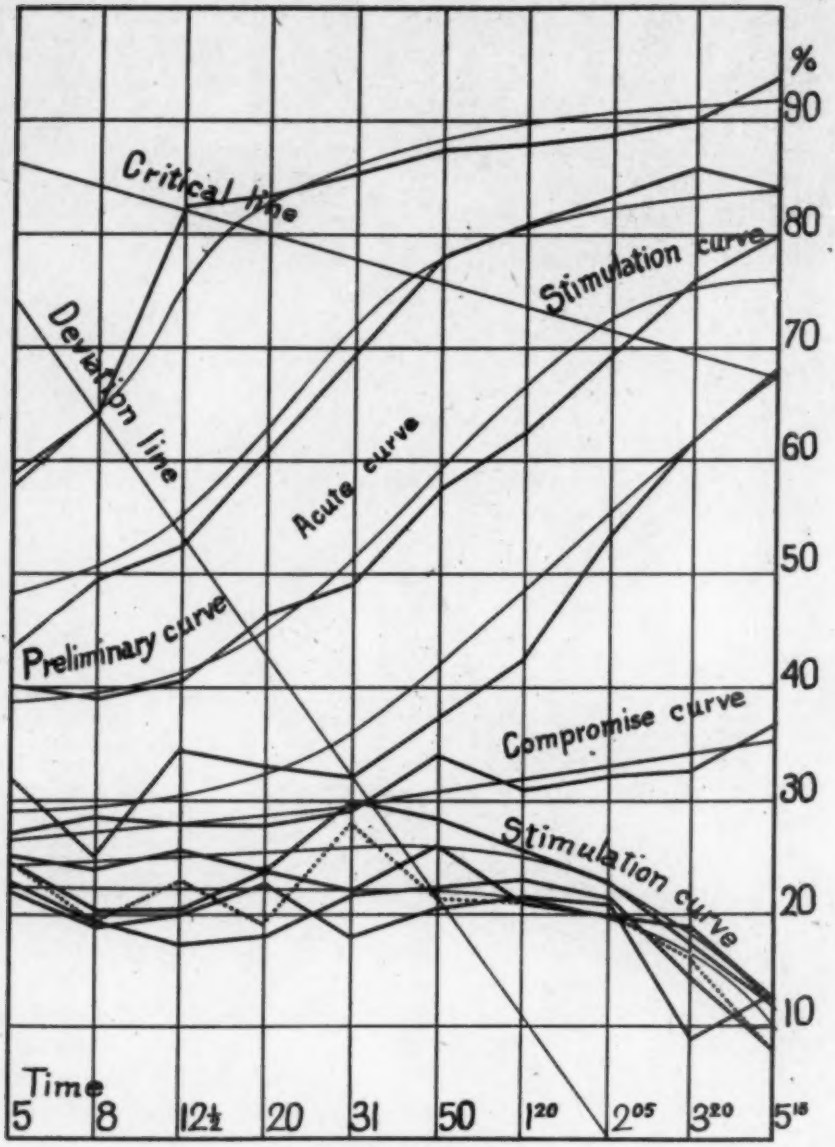
THEORY OF TOXICITY

By C. W. WOODWORTH

The most important work to be done in Economic Entomology is to lay a foundation of sound theories. The necessity of such work is well shown in the progress of fumigation where, for instance, the original publication [1] contained tables of dosage calculated on the assumption that the dose should be determined in proportion to the volume, and this erroneous theory still influences the thoughts of entomologists, though discarded from the first in actual practice. Again, when a careful study of the actual doses used for different sizes was made,[2] showing that the area of the tent corresponded much more closely than volume to the practice of fumigators, there was a universal adoption of this basis of calculation upon the erroneous theory that such a table correctly compensated for leakage. The only way a correct compensation can be secured is to measure the amount of leakage, which is now a very simple matter,[3] and then to use tables calculated for the various degrees of leakage.[4]

Each step in this progress was accomplished by efforts directed towards correcting the theory, and required the accumulation of a very large volume of data, since there are so many unknown variables that individual experiments are entirely unreliable. Many thousands of determinations were made in the study of leakage referred to above, and a series of 40,000 lots of scale insect eggs were used in obtaining the data discussed below. This quantity was not great enough to eliminate all the irregularities in curves shown in plate 28, but is without doubt the largest volume of laboratory data ever secured

[1] Bulletin 71, California Agricultural Experiment Station.
[2] Bulletin 152, California Agricultural Experiment Station.
[3] Circular 75, California Agricultural Experiment Station.
[4] Journ. Econ. Ent., Vol. iv, pp. 376–380. Bull. 220 and 257, California Agricultural Experiment Station.



Toxic phases

in any similar investigation and gives results of a very dependable character. The methods of study have already been described elsewhere,[1] and it will only be necessary to explain that this study presents the result of 200 sets of experiments, each set consisting of simultaneous determinations for each of the 100 points on the diagram, made with special care to insure that all the data in each set shall be comparable.

Each curve represents the percentages of the lots which failed to hatch after treatment in a certain density of gas through exposure for varying intervals of time. These intervals range from five minutes to five and one quarter hours. The intervals indicated by the vertical lines are in geometric progression. The horizontal lines represent the number of lots giving no hatch.

The strength of dose doubles towards the upper end of the table for each line, the topmost line being 512 times as strong as the weakest, which is dotted on account of its somewhat erratic position.

Seven theoretical curves are drawn which correspond very closely with the experimental data and show that very complex relationships exist. It is likely that the same facts will be found true for other insecticides and that we can establish, at least as a working hypothesis, the series of toxic phases shown on the diagram, with the definite relationships there indicated. These phases are as follows:

THE PRELIMINARY CURVE in which the toxicity is directly proportional to an increasing geometric series of time intervals, and for the stronger doses, is also directly proportional to an increasing geometric series of concentration intervals.

THE DEVIATION LINE is the center of a very evident zone where the toxic curves diverge. It seems to be inversely proportional to the toxicity during the preliminary period; that is, the less the killing the longer the interval, the increase of time corresponding with a decrease of dose being in geometric ratio and, therefore, making a straight line where the time intervals are plotted as in this chart.

THE ACUTE CURVE represents a different physiological action of the cyanid, possibly directly upon the nerve centers. It is a more abrupt and much longer continued action in the lower concentrations of the poison, resulting in a far greater difference in the time required to complete the action than in percent that finally dies. The proportional rate of killing during this acute phase is identical for all concentrations, the greater killing for low concentrations depending solely upon the longer time of action.

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[1] Science, Vol. xli, pp. 267–269, and Report California Agricultural Experiment Station for 1914, pp. 114–116.

THE COMPROMISE CURVE is well shown in the fifth curve. Here the direction of the curve seems to be the result of two forces and might easily occupy any one of a great range of positions according to the relative power of the two influences. As shown in the diagram it is very closely half way between the Acute curve above and the Stimulation curve below.

THE STIMULATION CURVE represents a benign effect of cyanid. The fact that there is such an action in the case of this chemical has already been pointed out.[1] These curves show, in this case, that more than half of the lots of eggs that would have failed to hatch under normal circumstances have been made to hatch by the long continued action of the cyanid. The beginning of this stimulative effect has the same relation to the deviation line that the Acute curves show, and the rate of stimulation is similar but in an opposite direction, suggesting that the same causes are responsible in both cases. There must be profound physiological changes which are essentially beneficent but violently poisonous when carried to excess.

THE CRITICAL LINE represents a second evidently significant physiological crisis, bearing the same quantitative relationships with the concentration of the gas as the deviation line but with a greater time factor, though qualitatively indentical. It measures the culmination of the violent action of the poison and the beginning of the recovery. Those not dead at this time have a fair chance of survival. Perhaps the production of antibodies provides for the reduction of the quantity of poison within the body.

The method of plotting the results of experiments of this kind should be such that the irregularities at the two ends of the curves should be approximately of equal magnitudes, for in this way one will give proper weight to all the data.

This was done in the present case, the time intervals being arranged logarithmically. The fact that by this arrangement the deviation and critical lines are straight indicates that in general the phenomenon occurs in proportional rather than in consecutive intervals.

The theory of toxicity which this study enables us to put forward is (1) that there are three separate effects produced by a poison depending on its concentration; (2) that there is a line of deviation beyond which their characteristics become most evident; (3) that acute poisoning reaches a crisis after which the rate of death rapidly declines, and (4) that these phenomena exhibit a series of very definite mathematical relationships.

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[1] Science, Vol. xli, pp. 267–269.

A NEW MIXTURE FOR CONTROLLING WOOD-BORING INSECTS—SODIUM ARSENATE-KEROSENE EMULSION

By F. C. CRAIGHEAD, *Branch of Forest Insects, Bureau of Entomology, United States Department of Agriculture*

During the past summer different substances were tried in an effort to kill wood-boring insects, such as *Goes* (work similiar to *Prionoxystus*) and *Cyllene pictus*. In view of the discovery by Dr. A. D. Hopkins that kerosene was effective on the locust borer (*Cyllene robiniæ*), this substance, kerosene emulsion, and carbolineum, were tried but proved of little value in these cases. The kerosene emulsion penetrated the wood and galleries but seldom was in quantity enough to kill the larvæ.

The idea occurred to poison the emulsion so that as it penetrated to the insects and they attempted to bore further, the poisoned wood would kill them. A soluble arsenate, sodium arsenate, was tried mixed with the water to be used in making the emulsion. A 5 to 10 per cent arsenical solution was used but it is probable that a much weaker strength will answer. The results were highly successful in all trials.

The same penetrative properties of the kerosene are retained, quickly soaking in several inches in seasoned wood and in living and seasoned wood through the frass in the larval mines often to a distance of ten to twelve inches.

Tests made on *Goes* mines in living trees showed that by painting the holes where the boring dust is exuded this solution quickly ascends along the sides of the burrow and through the frass, killing the larvæ in a few days. Hickory logs heavily infested with *Cyllene pictus* were washed with this solution, sponging it on the bark with a piece of cotton. In four days' time all the larvæ were killed and many had turned black. Mr. T. E. Snyder tested it on powder post beetles in seasoned hickory and oak. A week to ten days after one application all the larvæ were killed. Many were one and one-half to two inches in the wood.

As a preventative for wood borers, in construction timber, it has not been tested, but will no doubt give good results where the lumber is not exposed to severe weather conditions. Should the kerosene evaporate, the arsenic would remain deep in the wood unless leached out by contact with water.

NOTES ON ICHNEUMON LÆTUS BRULLÉ[1]

By HARRY H. KNIGHT

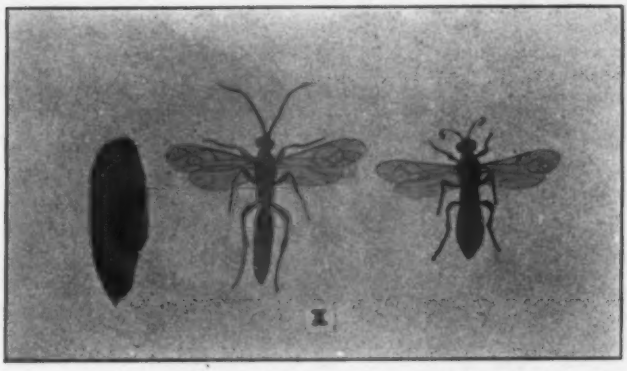
While breeding parasites from the army-worm (*Leucania unipuncta* Haworth) during the summer of 1914, males of *Ichneumon lætus* Brullé were bred in considerable numbers from the pupæ. The parasites began to emerge August 15 and continued to appear during the week following. By August 24 females of *Ichneumon funestus* Cresson and *Ichneumon canadensis* Cresson began to emerge from the pupæ. On August 25 a male of *I. lætus* was observed to copulate with a newly emerged female of *I. funestus*. The female was resting on an oat straw when the male approached from in front (Pl. 29, fig 2), grasped her quickly by the legs, and at the same time thrusting his abdomen below and clasping the ovipositor with the tip of the abdomen. Copulation was observed three different times and in each case it lasted about one-half minute.

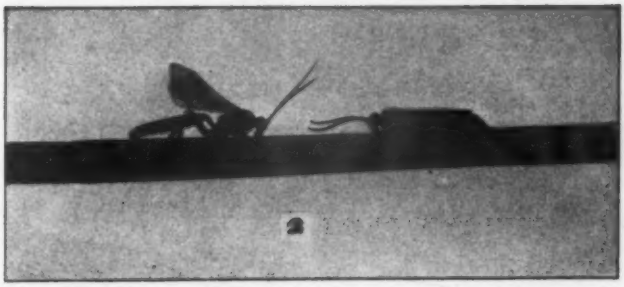
In rearing specimens it was noted that the abdomen of certain females was entirely ferruginous at emergence and then after a few hours acquired the black coloration at the base of the segments. *I. canadensis* and *I. funestus* are separated on the basis of the presence or absence of black at the base of the abdominal segments. A series of specimens shows a gradation of forms from the typical *canadensis* to *funestus*. From these observations it appears that they are females of the same species. The female of *I. lætus* and the males of *I. funestus* and *I. canadensis* have heretofore remained unrecognized. Brullé (1846) described *I. lætus* from a male. In a note following the description a female is mentioned and certain points of difference are described. Evidently this female was some other species for both Provancher and Cresson were unable to recognize the female of *I. lætus*. Say, in 1835 described the male *lætus* but instead of giving it a new name he referred to it as being the male of a previously described species, *Ichneumon paratus* Say.

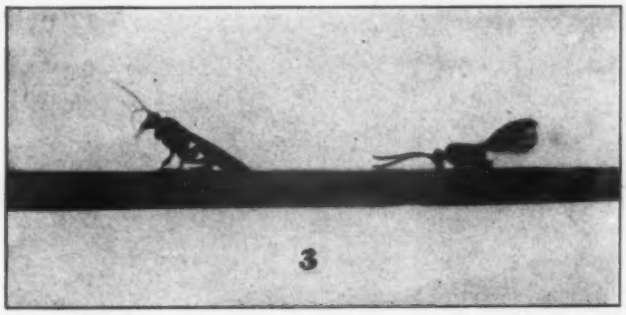
It may be concluded from the foregoing breeding experiments that *I. canadensis* Cresson and *I. funestus* Cresson are females of *Ichneumon lætus* Brullé. Since *Ichneumon lætus* Brullé has priority over Cresson's species the latter must be considered synonyms.

The males of *I. lætus* have been taken during the winter months in decaying logs. On a warm day last December the writer took a male specimen on the walk in front of the Cornell Insectary. On March 14, 1915, some twenty specimens, all females, were found hibernating

[1] Contribution from the Department of Entomology of Cornell University.







Ichneumon lætus

in a group about eight inches from the surface in a gravel bank. This lot of specimens gives a series showing both the *canadensis* and *funestus* forms. The abundance of the species at this time is undoubtedly due to the unusual numbers of the army-worm during the past summer.

My thanks are due Dr. J. C. Bradley who gave much assistance in the determination of specimens.

SYNONOMY OF *Ichneumon latus* BRULLÉ

1835. *Ichneumon paratus* Say. (male only).
Bost. Jour. Nat. Hist., I: 228 (LeConte ed.)
1846. *Ichneumon latus* Brullé (male only).
Hist. Nat. Ins. Hym., IV: 303.
1864. *Ichneumon funestus* Cresson (female).
Proc. Ent. Soc. Phil., III: 166.
1869. *Ichneumon canadensis* Cresson (female).
Trans. Am. Ent. Soc., I: 308.
1875. *Ichneumon hoesitans* Provancher (female).
Nat. Can., VII: 80.
1877. *Ichneumon hoesitans* Prov. = *funestus* Cress.
Cresson, Trans. Am. Ent. Soc., VI: 179.

EXPLANATION OF PLATE 29

Fig. 1. Pupa of army-worm showing the parasite before emerging; male (center) and female of *Ichneumon latus*.
Fig. 2. Male of *I. latus* approaching the female.
Fig. 3. Male and female cleaning antennæ and wings.

SOME NOTES ON THE WESTERN TWELVE-SPOTTED AND THE WESTERN STRIPED CUCUMBER BEETLES[1]

By R. A. SELL

THE WESTERN TWELVE-SPOTTED BEETLE (*Diabrotica soror* LECONTE)

The western twelve-spotted beetle (*Diabrotica soror* Lec.) is often called "the western flower beetle" because it is so frequently seen on flowers. Terming it simply "the diabrotica" as they do in some parts of California is not satisfactory, for the danger of confusing it with

[1] This article contains an outline of an investigation made under Mr. E. O. Essig at the University of California during the summer of 1915 (June 20 to August 30). Many difficulties were encountered in the work on *Diabrotica soror* Lec., so that the paper is for the most part a preliminary survey. With *Diabrotica trivittata* Mannerheim it was very different since every observation tended to strengthen the belief that it differs very little from *Diabrotica vittata* Fabricius of the Middle and Eastern States. *Diabrotica soror* Lec. has very little in common with either of the striped forms.

other forms, as the striped cucumber beetle (*Diabrotica vittata* Fab.) or the painted cucumber beetle (*Diabrotica picticornis* Horn), is apparent. In some parts of the country the corn root-worm (*Diabrotica duodecimpunctata* Oliv.) is styled "the diabrotica." As a popular name "the western flower beetle" is fairly satisfactory, for, while it may attack the leaf, the stem or the fruit, it shows a decided preference for the flowers.

FEEDING HABITS. The insect feeds upon many different kinds of plants; its choice depending upon the locality, the season, or the stage in its life history. In the vicinity of Berkeley it feeds to some extent upon more than five hundred varieties of plants and it is positively harmful or highly destructive to at least one hundred of these.

The flora of this region is especially rich; the range of plant life from the crest of the Berkeley Hills to the bay is very extensive, and the University of California, through the departments of Botany, Agriculture and Landscape Gardening, has introduced various forms of plants from South America, Africa, China, Japan, Australia, Ceylon, Russia and other foreign countries. Counting the native plants, the cultivated plants and those plants that have been introduced for experimental and ornamental purposes they would number several thousand. The following is a list of fifty of the more common and more generally distributed plants upon which the *soror* feeds: beet, bean, pea, marguerite, nasturtium, rose, holyhock, cucumber, pumpkin, muskmelon, watermelon, poppy, alfalfa, sweet corn, potato, pepper, artichoke, tobacco, radishes, mustard, clover, lettuce, eggplant, parsley, plum, apple, pear, peach, cherry, currant, canna, dahlia, foxglove, dandelion, pinks, peony, violet, aster, buttercup, sunflower, black-eyed-susan, primrose, bleeding-heart, lily, burdock, thistle, verbena, morning-glory, wistaria, dog-fennel.

Its work on cultivated flowers is very noticeable, for it makes unsightly holes through the petals and destroys their beauty, but it is no less destructive to the essential organs for it may eat the upper part of the pistil (stigma), dig into the ovary or attack the anthers. Since it is especially fond of pollen and nectar it can frequently be found in a flower doing no apparent damage.

By gnawing holes through the thin and tender parts of the leaves it destroys the foliage and causes a loss of the sap, which is the life blood of the plant, besides interfering with photosynthesis or starch making, a vital process of the plant, and making a way for fungus diseases to attack the injured part.

It sometimes attacks very young cucumbers or muskmelons, the pods of young beans, cauliflower, and the fruits of eggplant and even tomatoes.

A study of the feeding habits of this insect is interesting. It will not eat just any plant and must become adapted to a change of food. Even when confronted with starvation a number of them would not eat the leaves of mullein, thistle, artichoke, pond rushes, dog-fennel, onion tops, red oak, chestnut, maidenhair, pine, spruce or cottonwood. From a diet of beet leaves they did not take readily to eating leaves of maple, peach, plum, cherry, gooseberry, currant, potato or tomato, but finally developed an appetite for them.

After a pair had been fed on beet leaves for several days prickly lettuce was substituted. They did not eat it for two days, then, after a period of six hours from the time they had eaten rather heartily, the male died. In the field prickly lettuce is a perferred host plant of great numbers.

Another pair that had been eating beet leaves were fed apricot peelings. They began eating before night but died the next day.

Ten beetles were fed on beet leaves for six days. After being without food for one day they were given apricot peelings. Six of them died but the other four adapted themselves to the change of diet. After the university had received information of damage to potato tops some experiments in adapting beetles to this food were attempted. Twenty-five beetles that had been eating beet leaves were fed potato tops. At first they would not eat and two of them died. In four days the others had become accustomed to the change. Then they were also given beet leaves but they preferred potato tops. When the potato tops were removed they fasted one day and then resumed the beet leaf diet. None of them died.

Fifty beetles, taken in a beet patch, were fed potato tops. The second day they began to eat and two of them died. After they had been eating well for three days they were fed beet leaves which they would not eat at first. In two days they had adapted themselves to the change.

Under certain conditions this species would eat some part of the flower or fruit of every plant upon which it was observed during the entire period of this investigation.

Occasionally one of the beetles was found in a colony of aphids, walking around among them and gathering up the honey dew but it did not seem to be guided by a sense of smell since numbers of them did not congregate around the bait.

Field Habits. In order to study the range and field habits of this insect large numbers of them were marked by painting with a brush and ink. Several kinds of ink were tried with variable results. White ink and black India ink were fairly successful but red India proved to be the most satisfactory.

Of fourteen beetles marked June 24 from five to ten of them were seen each day until July 1 when eleven were marked. From July 1 to 9 four to fourteen of the twenty-five were seen each day. Of fifty beetles marked July 9 six to twenty-eight were seen each day until July 23. About July 12 great numbers of smaller, more active, light green beetles appeared, which could be readily distinguished from the prevailing form. Of fifty light green beetles marked July 15 one to four were seen each day until July 23. Of fifty light green beetles marked July 22 the record was: 23d four, 24th one, 25th none, 26th one, 27th none.

One male beetle was found every day on a canna for twenty days. Two females were found on a beet plant every day for eleven days. A beetle will leave and return to a favorite plant from day to day where it will frequently spend the night. All the beetles became active about July 20. It was found by marking a large number that they came from the Berkeley Hills down into Berkeley and Oakland.

It seems that there is a period of comparative rest, followed by a period of great activity. Each of these periods must have a definite relation to some stage in the life history of the insect.

Enemies. The tachina fly (*Celatoria diabroticæ* Shim., *Celatoria crawii* Coquillett), mentioned by Mr. Coquillett as one of the natural enemies of *Diabrotica soror* Lec., was not very common in this section of the country this year, for less than twenty examples of it were noted among several thousand beetles.

A spider, unidentified at this time, killed a few of the beetles.

The only birds observed actually eating these insects were the purple finch, the bush-tit, the linnet and the canon wren.

Color Phases. On the 20th of June these beetles were not very plentiful. Their wing covers were the normal leaf-green and the bodies of the sexes were very much alike. By July 12 two color phases could be detected in the field—the normal light green and a yellowish green. By August 1 a third color phase could be detected—a pale faded green. The latter was an old-age type for they soon died. But whether or no it had passed through the other phases of normal green and yellowish green, or represented a frail generation, is an unsettled question.

Eggs. During the mating season females are very heavy with eggs and the abdomens of the males are somewhat enlarged. It appears that the eggs are rather completely developed before mating takes place. At this stage the beetles are ravenous eaters and will stay with one plant almost continuously, seldom leaving it. When attacked these heavy forms simply let all holds go and roll down among the leaves. If they fall to the ground they immediately begin to ascend the plant as if anxious to get back to the feeding place. Before the

mating period they either fly or attempt to conceal themselves on the ground.

The eggs are oval with rounded ends and are rather large for the size of the adult. They are light lemon-yellow and almost transparent. A typical cluster contains four or five. Being rather frail and adapted to moist soil and the surface of the growing plant, they will dry up when exposed to the air.

A number of egg-laying records were kept. The following record of a female, placed in confinement with a male June 24, 1915, is a typical example:

June 24, placed in confinement, one female and one male.
July 13 ..... 62 eggs deposited.
July 14 ..... 4 eggs deposited.
Aug. 6 ..... 61 eggs hatched.
Aug. 18 ..... 48 eggs deposited.
Aug. 19 ..... female died.

The first sign of hatching is a dark spot near the end that is attached to the plant. As it develops the shell is rounded out, thereby tending to make the egg shorter and thicker but, as the other eggs are next to it, there are some indentations making it conform to the crowded conditions.

REMEDIES. Arsenate of lead spray (one ounce arsenate of lead, one gallon water) will kill some beetles and act as a repellent for a few days after it is used. In the experiments tried it killed less than 9 per cent, but it almost relieved the plants from attack for three days.

Bordeaux mixture (unslacked lime 4, copper sulphate 4, and water 50) was tried. It killed 12 per cent in confinement, but in the field it was not as good a repellent as the arsenate of lead spray.

Some experiments were made with a poison bait spray that seems to indicate a remedy worth while, but the data are by no means complete as to how it would work under ordinary field conditions.

THE WESTERN STRIPED CUCUMBER BEETLE. (*Diabrotica trivittata* MANNERHEIM)

The western striped cucumber beetle (*Diabrotica trivittata* Mann.) is found with the western twelve-spotted cucumber beetle (*Diabrotica soror* Lec.) on pumpkins, cucumbers, squashes, muskmelons, etc., but it is of comparatively small importance. It is closely related to the striped cucumber beetle (*Diabrotica vittata* Fab.) and its habits and life history, so far as they have been observed, are identical, with two exceptions: first, in this locality its feeding habits are more general and, second, it has two generations in a season.

On the "Island Farms" at Alameda the work of the larvæ upon the roots of the cucumber plants was identical with that of the striped cucumber beetle (*Diabrotica vittata* Fab.) in Minnesota.

The adults are not usually of sufficient importance to demand remedial measures, but the larvæ will destroy a patch of cucumbers in a very short time. Eggs are deposited about two inches below the surface of the soil on the tap root of the plant. When they hatch the young larvæ begin working upwards on the root-stalk and appear above the ground in two or three days. Soon the flat sides of the stalk near the corners begin to turn white and the leaves nearest the roots show a white border; then the whole plant begins to wither, the small cucumbers curl and assume awkward shapes, and, if the insect continues, the plant dies.

Tobacco extract, nicotine, is a successful remedy. Various forms of this extract may be had at the drug store, at about two dollars per pound for 40 per cent solution. Counting one teaspoonful of the solution to a gallon of water, a pound can will be sufficient to treat one thousand hills and a man can treat fourteen hundred hills a day.

When the larvæ appear on the stalk, just above the surface of the soil, take a narrow half pint cup and pour the solution carefully against all sides of the stalk in such a manner that it will run down. The solution will kill the larvæ without touching them, but the burrows in the stalk may be very deep—the larvæ will finally work to the pith—in which case a quick splash of the liquid into the burrow would be most likely to kill the insect. Everything depends upon the way in which the liquid is applied. Care and judgment are equally demanded. A good way is to squat down with the cup of liquid in one hand while keeping the other hand free to carefully move the plant that there may be no guess work about where the insect is working and that the liquid may be poured in the right place.

Department of Entomology, University of California,
Berkeley, Cal., August 30, 1915.

LEPTINOTARSA DECEMLINEATA SAY

By W. O. Ellis

During the summer of 1913, while acting as an assistant in the Entomological Division of the Iowa Agricultural Experiment Station, the following record on oviposition was obtained:

From a female captured July 7 and placed in confinement with a male, the writer obtained a total of 1,686 eggs. The experiment continued to September 1, or a period of fifty-five days. On July 28 the

largest number for a single day from this adult was deposited—110 eggs. Girault & Zetek[1] have taken 1,578 from a single beetle.

Date	Number per Cluster				Total
8 July			25		25
9			30		30
10			24		24
12			29		29
14			7		7
15			21		21
19			56		56
24			9		9
28		19	34	57	110
29		22	40	46	108
30		17	42		59
31		10	17	29	56
1 August		10	35		45
2		9	16	25	50
4	12	19	30	36	97
6		42			42
7		34	17	40	91
8		13	39		52
9		10	28		38
11			42		42
12			29		29
13		10	17	41	68
14		13	22	8	43
15		14	21		35
16			26		26
17		20	29		49
18		18	28		46
19		38			38
20		32	9		41
21		11	31		42
22		10	35		45
23			36		36
25		18	13	21	52
26			21		21
27		13	27		40
28			39		39
29			14		14
30			13		13
31			18		18
Total					1,686

[1] Ann. Amer. Ent. Soc., Vol. IV, p. 71.

EXPERIMENTS IN THE CONTROL OF THE POPLAR AND WILLOW BORER (CRYPTORHYNCHUS LAPATHI LINN.)

By Robert Matheson, *Ithaca, N. Y.*

The poplar and willow borer is a serious pest in nurseries of New York state and at present is doing much damage. It is also a serious pest to ornamental poplars and willows, including basket willows. The most extensive depredations of this pest occur in nurseries where large blocks of these trees are grown, and in some cases the annual loss is very considerable. During the past two years, as time would permit, control experiments have been conducted in two of our large nurseries. This work has been made possible through the courtesy of the proprietors, and to them I desire to express my thanks.

Although considerable biological data have been gathered in the course of this work, only the control experiments and their results will be discussed here. Since the publication of Schoene's work in Bulletin 286 of the New York Experiment Station at Geneva very little has been done in reference to this insect. As the result of his work he recommended the use of bordeaux mixture containing an arsenical. This spray should be applied during late July in order to destroy the adults which feed indiscriminately on the bark of the trees. Owing to the difficulty of spraying nursery trees this recommendation has not been adopted, and I know of no experiments which have been conducted on a large scale in order to test the efficiency of this method.

To present the method of experimentation more clearly, a brief synopsis of the life cycle of *C. lapathi* Linn. is necessary. The eggs are deposited in August, September and October in two- or three-year-old stock in the nursery rows. I did not succeed in finding eggs in younger stock. The eggs are laid exclusively in the corky portions of the tree, just below the bark in the cambium layer. They were found most commonly around lenticels, near buds and branches, or in growths caused by pruning. These eggs hatch in late August, September and October. The young grubs feed on the bark and grow slightly before hibernation. In these small chambers, just below the surface of the outer bark, the young larvæ pass the winter. Feeding begins early in the spring, the larvæ attacking the cambium layer and often girdling the trees. In late June they bore into the heart of the trees, forming the pupal cells. Pupation takes place during July and the adults begin emerging in late July and August. The beetles feed for a short time before beginning to oviposit.

Early in my observations I was led to the conclusion that this insect could be destroyed by some contact spray applied to the trunks of the trees in the autumn after the leaves have fallen, or in the spring before

the young larvæ have begun actively feeding. This seemed very reasonable, owing to the quite exposed condition of the young larvæ in their burrows. It seemed to me that some of the emulsions ought to penetrate the outer bark or be absorbed through the very small amount of frass at the entrance to the burrows and destroy them. With this conclusion, I determined to try varying strengths of miscible oils and kerosene emulsion applied both in the fall and spring. In order to secure a stronger penetrating fluid, it was felt carbolineum avenarius ought to be given a thorough trial, but I had to go very slowly as very little is known about the constituents of this preparation. Furthermore, very little is known as to its effects on actively growing or dormant trees.

In the fall of 1913, seventy-six badly infested two-year-old poplar trees were secured and planted at the insectary. On December 1, 1913, part of this block was treated with scalecide at varying strengths and also a few trees with carbolineum and its emulsion[1] as indicated in the table. This experiment was closely watched the following spring but no injury to the trees could be noted, except that the carbolineum treated trees did not seem so vigorous. However, they grew and are now (1915) large healthy trees. Examination and careful count of the burrows in all of the trees was made on June 17, 1914. The number of larvæ present per tree is shown in table I.

TABLE I. *Cryptorhynchus lapathi* LINN.

Treatment	When Applied	Number Trees	Examined	Number Infested	Larvæ per Tree (Average)	Not Infested	Per Cent Infested
Scalecide 1–5[2]	Dec. 1, 1913	10	June 17, 1914	3	2.6	7	30
Scalecide 1–8	"	10	"	4	1.25	6	40
Scalecide 1–10	"	10	"	7	2.3	3	70
Scalecide 1–12	"	10	"	8	1.9	2	80
Scalecide 1–15	"	10	"	5	2	5	50
Carbolineum 1–1	"	2	"	0		2	0
Carbolineum Emulsion 1–2	"	2	"	0		2	0
Check		22	"	10	2.6	12	45.5

In the spring of 1914 a series of experiments was undertaken in a large nursery. Three-year-old stock was chosen as it was the most available at the time of doing the work. Badly infested trees were selected at one side of a large block which had been recently dug. Directly across the roadway was a block of young poplars. On March 31 scalecide, of varying strengths, carbolineum, and carbolineum emulsion were applied to the trunks from the ground up to the young

[1] The carbolineum emulsion was prepared as follows:—1 lb. sodium carbonate, 1 quart hot water, 1 quart carbolineum avenarius. The sodium carbonate was dissolved in the hot water and the carbolineum was then added, stirring vigorously.

[2] All dilutions are with water.

growth. The day was fair but began raining before the various treatments were completed. However, the rainfall was slight so it should not have had any effect on the insecticidal qualities of the preparations.

The treated trees were examined carefully on May 14, 1914. The various treatments had no effect on the growth of the trees, every tree growing vigorously, and there being no difference as far as I could detect between the checks and those under experimentation. In the checks the larvæ were actively at work and their abundance was indicated by the amount of sawdust exuding from the numerous burrows. All the trees treated with different strengths of scalecide showed just as high a percentage of infestation as the checks. This preparation had no appreciable effect. In the trees treated with carbolineum, either pure or as an emulsion, not a trace of infestation could be found. After searching for several hours one shrivelled and blackened larva was discovered in its burrow. However, I did not wish to injure the trees too much by cutting into all suspicious egg punctures.

This experiment was again carefully examined on June 18 and confirmed my previous observations. The checks and those treated with scalecide were nearly all badly infested, many trees with as many as eight to ten borers present, while a few both in the treated and checks were apparently free. Those trees treated with carbolineum and its emulsion were growing even more vigorously than the untreated ones, and not a single trace of the work of the borer in any one of the twelve treated trees could be discovered. These preparations colored the trunks of the trees a beautiful brown, but other than that no injury could be seen.

Fearing that such a perfect control might be due to other causes than the effect of the treatment, a larger series of experiments was planned for the fall of 1914 and spring of 1915. Discarding the miscible oils, kerosene emulsion was given a trial as it has been recommended for the control of the locust borer (*Cyllene robiniæ*). In a block of over 10,000 trees ready for digging in the fall of 1915, rows were selected at the end which showed, the greatest amount of the feeding work of the beetles. On December 4, 1914, groups of twenty trees were each treated with pure kerosene emulsion, carbolineum and carbolineum emulsion. Rows were left between for checks. The material was applied directly to the trunks up to the younger growth. On April 9, 1915, twenty-five trees were treated with pure kerosene emulsion, fifty with carbolineum emulsion and twenty-eight with pure carbolineum. Just previous to these treatments the trees in the whole block had been pruned carefully. The material was carefully brushed over the trunks, covering all the cut surfaces of the recently removed branches.

The experiment was examined on June 28. The block as a whole showed a severe infestation, sawdust being present at the base of a

great many trees, and this could be seen for a long distance down the nursery rows. In the rows treated with carbolineum or its emulsion no sawdust could be seen and the trees were vigorous growers, the trunks showing a beautiful brown color but not an indication of borer work. The kerosene emulsion had no appreciable effect, nor did it injure the trees, though it was applied in large quantities. The treatments applied and results obtained may be quickly ascertained by consulting Table II. Kerosene emulsion applied pure in the fall seems to have had some effect but one cannot safely draw conclusions. Thirty per cent infestation is high, though the average number of larvæ per tree is a minimum. The carbolineum applied pure and its emulsion gave almost absolute control and seems to me a very simple and effective means of control under nursery conditions.

TABLE II. *Crypterhynchus lapathi* LINN.

Treatment	When Applied	Number Trees	Examined	Number Infested	Larvæ per Tree (Average)	Not Infested	Per Cent Infested
Kerosene emulsion (pure)	Dec. 4, 1914	20	June 28, 1915	6	1	14	30
" "	Apr. 9, 1915	25	"	16	2.25	9	64
Carbolineum.....	Dec. 4, 1914	20	"	0	..	20	0
" emulsion.....	Apr. 9, 1915	27	"	0	..	27	0
Carbolineum "	Dec. 4, 1914	20	"	0	..	20	0
" "	Apr. 9, 1915	50	"	0	..	50	0[1]
Check.....		116	"	56	2.4	60	48.3

The cost of these various treatments has not been ascertained. The carbolineum costs at retail prices $1.00 per gallon, and one gallon should treat at least one thousand to fifteen hundred trees. I am planning to carry on this work on a large scale during the coming year and shall probably treat twenty to thirty thousand trees. In this way the cost of treatment may be determined under commercial conditions.

ESTIMATING THE NUMBER OF GRASSHOPPERS

By E. D. BALL

In most of our published works on injurious insects such terms as abundant, swarming, numerous and common are used to designate the number of individuals concerned in a given attack.

The writer has found that in codling moth work the exact number of worms per tree and per hundred apples, either present or to be anticipated from previous counts, are vital facts in the problem of control, less than one or two worms per hundred apples indicating a good condition—more than the number requiring additional control measures.

[1] One half grown larva was found in July, evidently due to lack of thoroughness in treatment.

In the sugar beet "curly-leaf" studies the actual number of leaf hoppers per beet was found to be closely proportional to the damage done under similar climatic conditions, the difference between one and two hoppers per beet making all the difference between success and failure in crop production in certain cases.

Believing that more definite information would be of value in discussing grasshopper control, the writer attempted to obtain estimates of actual numbers concerned in some recent outbreaks. The results proved to be of more value than anticipated, as by putting egg counts and swarm counts together a better estimate of danger could be given than formerly, and, also, that by using these actual figures the danger was brought home to the people in a way to convince them and arouse them to united action, such as had never before occurred.

It is too bad that we cannot give the actual amount of food consumed per hopper and translate a billion grasshoppers into bushels of oats, bales of hay, or tons of sugar beets.

In estimating the number of eggs laid by a swarm of *Camnula pellucida*, the approximate area infested was determined after discing the breeding ground so that the eggs showed on the surface (the breeding grounds having been located the previous August).

The heavily infested portion was found by counts to average:

To the square inch	175
To the square foot	25,000
To the acre	1,000,000,000

The area in one valley that was heavily infested was about twenty acres or about *twenty billion eggs* ready to hatch. That statement was sufficient to arouse the community, so that sixty teams and men turned out for one day and destroyed them.

The young hoppers start to migrate as soon as hatched and dry, always traveling towards the sun. They travel only on warm days, stopping if it clouds up and becomes cool or rains. In estimating the numbers in one of the smaller migrating swarms, the central part of about three hundred and twenty acres was found to average as follows:

To the square inch	1
To the square foot	150
To the square rod	41,000
To the acre	6,500,000
To the square mile	4,000,000,000

or that part of the swarm equalled two billion grasshoppers. Around this center there was an average of from ten to fifteen to the square foot on about four square miles, or one and one-third billion more, or a total swarm of *between three and four billion hoppers.* This was

considered to be an insignificant swarm as compared to those of 1902, when a total of ten times as many were caught in the county, or two hundred and seventy-four tons. Estimating that five tons were caught from the swarm enumerated above (there was some mixture of swarms) and that they ran about the average catch of eight million to the ton, then this catch of forty million out of the swarm of three thousand, three hundred and thirty million would show that about one hopper in every eighty-seven was caught by balloons. If the same proportion were caught in 1902, and there were less if anything, San Pete Valley had swarms aggregating somewhere near two hundred billion grasshoppers that year.

These swarms were caught for bounty by using "balloons," catching beginning as soon as a swarm was found large enough to pay, which meant the capture of from four hundred to eight hundred pounds per day per outfit. In this way many swarms were caught while the insects were quite small; others were not found until later when they would be larger. Many swarms contained hoppers of all sizes, and finally, late in the season, some catching was done on the breeding ground where only adults were present, so that the average "catch" was probably about half grown. The following table gives the number by weight at different ages:

APPROXIMATE WEIGHT OF GRASSHOPPERS

	Per Ounce	Per Pound	Per Bushel (60 pounds)	Per Ton
Egg—or just hatched young	95,000	1,500,000	92,000,000	3,000,000,000
One week old	5,000	80,000	5,000,000	160,000,000
½ to ¾ grown—large enough to catch easily	1,000	16,000	1,000,000	32,000,000
Average catch—from small to adult	250	4,000	250,000	8,000,000
Adult females	55	900	50,000	1,800,000
Adult males	115	1,850	110,000	3,700,000

SOME DEVELOPMENTS IN GRASSHOPPER CONTROL

By F. M. WEBSTER, *In charge of Cereal and Forage Insect Investigations, Bureau of Entomology*

During recent years, first the Criddle mixture and soon afterward the poison bran bait, came rapidly to the front as the most practical and efficient measures that could be applied in protecting the crops of the farmer from attacks of grasshoppers which for many years have, with greater or less frequency, over-run his fields and destroyed his crops.

While in many cases—perhaps the majority—excellent results have been obtained by the application of either one of these two measures, nevertheless, it frequently occurred that such results proved entirely unsatisfactory. This has been the case occasionally, even when these poisons were being used in the hands of expert entomologists. It has, therefore, for some time, appeared desirable that investigations be taken up with a view to discovering the determining factor in such failures, as they could not, in all cases at least, be attributed to lack of care in preparing and applying these mixtures.

In fact, very often farmers expected to get results in a few hours, whereas the full effects of the poisons have been found by all of the men conducting these experiments to extend over three or four days' time.

With this situation in mind, experiments were undertaken by four of the cereal and forage insect field stations which together covered a territory extending somewhat interruptedly from the Atlantic to the Pacific coasts.

For upwards of forty years there have been periodical outbreaks of several species of grasshoppers in the Merrimac and Connecticut River valleys in New England, originating in the intervales along the river bottoms. At no time have these outbreaks been satisfactorily controlled and they have, in the past, cost the farmers located in these valleys, immense sums of money. It was with a view to establishing a systematic piece of investigational work that the writer made a survey of the Merrimac valley during the summer of 1914.

The particular species of grasshoppers involved in these New England outbreaks were *Melanoplus atlanis*, *Melanoplus bivittatus*, *Melanoplus minor*, and *Camnula pellucida*, besides one or two other less important species.

With a view of determining whether or not it was possible to control these outbreaks, Mr. Harrison E. Smith was detailed to take up the work in New England, and carry it on during the spring and summer of 1915. One of the first obstacles to be encountered was the rather surprising fact that the young grasshoppers were much more difficult to kill with the poison baits than were those fully developed. The doubling of the amount of fruit used in the poison bran mixture, and adding that ordinarily used in this mixture to the Criddle mixture, eliminated this difficulty to a considerable extent, as the baits with the additional fruit appeared to be more attractive to the young grasshoppers. Still, there were failures even in cases where these poisons were used against full-grown insects, and even now the young up to the third instar do not seem to yield readily to these baits even with the increased amount of fruit and double the amount of the bait ap-

plied per acre. This was puzzling for a considerable time until it was learned that the failure was largely due to the drying out of the baits before the grasshoppers had been attracted to and eaten sufficient of them to be killed from the effects of the poison. This difficulty was eliminated by placing the baits in the fields in the early morning, before sunrise, so that the insects as they began to feed would be attracted by and feed upon the poison. Mr. Smith's work in New England has demonstrated that, over large areas, the experiments in some cases covering six or seven hundred acres, the results were the destruction of 95 per cent of the grasshoppers at an expense of from seven to thirteen cents per acre. With the Criddle mixture, 80 per cent of the full-grown grasshoppers were killed over the entire area of 30 acres at an expense of 6½ cents per acre.

As illustrating the actual results of the use of these poison baits, it may be stated that on a farm near Franklin, N. H., two applications of the poison bran bait resulted, in certain places, in as high as 550 dead grasshoppers in the space of a square foot. Furthermore, some of this work was carried on in pastures where valuable cattle were continuously grazing and in no instance did any domestic animal or bird suffer the least ill effects, so far as could be observed. During the first week of the following September over these treated fields there was not to be found on an average one individual to the square rod.

During the last few years many complaints have been received of attacks of grasshoppers in Florida and recommendations involving the use of these poison baits usually resulted unsatisfactorily, wherever results were reported at all. The species involved was the large "lubber" grasshopper, *Romalea microptera*. Farmers in many sections became discouraged and were convinced that these poison baits could not be used effectively against this pest. Mr. R. N. Wilson, in charge of the field station at Gainesville, Fla., took up the work of determining the cause of such failures. While the actual cause of these failures was not determined, it *was* learned by actual experiments that the poison bran bait, properly prepared and applied would work thoroughly and effectively in destroying these grasshoppers. After carrying out a series of experiments, Mr. Wilson induced five farmers in the vicinity of Fellsmere, Fla., to make careful observations during the following two or three days, and report results. As reported to him, this bait not only attracted the grasshoppers, but killed at least 50 per cent within twelve hours, while these farmers, by placing the grasshoppers in confinement after their having fed on the poison, found that all died within 48 hours. The result of the experiment among the farmers was that, as expressed by one of them: "We now

feel that we have the grasshopper situation well in hand and that, thanks to you, the problem is solved."

Another experiment carried out by Mr. Theodore D. Urbahns at Gustine and San Diego, Cal., resulted equally satisfactorily. In this case the species involved were *M. differentialis*, *M. uniformis*, *M. destructor*, and *Camnula pellucida*. The usual formula was used by Mr. Urbahns, except that 6 lemons were used for each 25 pounds of bran, with 2 quarts of cheap syrup and 3 gallons of water. Mr. Urbahns was able to protect alfalfa fields where the plants were 18 inches high and the insects feeding destructively along the border of the field. In his experiments he found that alfalfa meal was about equal to wheat bran in value, thus giving an alternative where farmers can obtain alfalfa meal more readily than wheat bran, the price being practically the same. Sugar beet pulp was also used but its effectiveness was found to be of shorter duration than that of the bran or alfalfa meal.

Very satisfactory results were obtained with this poison bait mixture by Mr. E. L. Barrett of the Pasadena, California, laboratory in experiments carried out by him in the Imperial Valley, covering two areas, one of about 20 acres, on a ranch at Holtsville; and another of about 10 acres, near Brawley, Cal. Seventy-two hours after the poison was put out, there were found on an average of about 150 dead grasshoppers per square yard. As the effects of the poison would extend beyond that time, it is free to presume that the destruction of these insects were still greater than these figures would indicate.

An attempt to control grasshoppers by these poisons in the vicinity of Tempe, Ariz., was ineffective, and we had a recurrence of the conditions where an expert entomologist failed to secure satisfactory results with the poison. Later, however, experiments were carried out in this same locality, the only difference in the bait being that instead of an ordinary good grade of molasses, sorghum molasses was substituted. Otherwise the same formula was used as that employed by Mr. Urbahns, excepting that 2 gallons of water per each 25 pounds of bran was used in preparing the mixture. The application was made August 12. Two days later the average count over the field was 167 dead grasshoppers to the square rod, while as a final result 95 per cent were killed. Here the species involved was chiefly *Melanoplus differentialis*. Thus it has been learned that the chief cause of failure has been in that, when this poison was used against the young grasshoppers, too small amounts of fruit were utilized in making the bait, and the failures when used against full-grown grasshoppers were largely in that the baits were lacking in moisture and hence less attractive when the grasshoppers began to feed upon them. Then, too, there

seems to be something in the nature of the molasses or syrup used as is evidenced by the results obtained in Arizona.

Perhaps, as indicating the rapid advancement in applied entomology, we might present as a contrast the following extracts from Curiositäten der *Physisch-librarisch-artistisch-historischen Vor- und Mitwelt*, etc., periodical published by Vulpius in Weimar 1811, I, p. 390:

"Aventinus relates the oldest instance in the Bavarian Chronik (p. 302) at the time of King Ludwig IV (reigned 936–954) the large grasshoppers came on the Rhine and devoured cereals, grasses, and vegetation of that kind. The priests held great processions, parading with the sacred objects about the fields, and prayers in the churches, in a word, a great spiritual agitation developed, 'but nothing would help,' adds the chronicler."

"In the 14th century, relates Uland in his writings on the history of poetry and sayings, the Bishops of Thur and Lausanne spoke to the entire church train about the robber fishes, earth worms and grasshoppers. Previously there used to take place a regular trial before the church court with all the rules of jurisprudence, the defendants were called, an attorney was assigned them on appearance, who dealt with the prosecutor, and then only rendered decision."

"As late as 1479 in the Canton of Bern there was great insect damage. The depredators were invited before the church court of the Bishops of Lausanne, to which diocese Bern then belonged, and after trial they were solemnly given the ban in the name of the holy Trinity. The Bern city recorder, who presents this fact, adds that 'it did not help.' "

There are occasions when the use of a hopperdozer is, temporarily at least, profitable, as for instance while the materials to be used in the baits, and which are not always quickly obtainable, are being secured, and when it is desirable to put immediate stop to the work of these pests. A cheap and easily constructed hopperdozer (see fig. 21) has been devised by the farmers of Kansas which may be described as follows: The frame is constructed of two by fours (2 x 6 is better if land is rough and hilly), 16 feet long, with 4 compartments to keep from sloping endwise on side hill land, and the width of a sheet of galvanized iron. Have runner on each end and one in middle, put on with screws; 2 iron loops on each end, 3 or 4 on back side. Make wooden standards 36 inches (or the width of common cotton factory cloth) long to fit in the loops, with shoulder so they will not slip down. Put them in place, then stretch the cloth around two ends and back side and tack in place with large head tacks. The idea of this canvas back is to make pan lighter and when not in use the standards can be pulled out and cloth rolled up and stored in dry for future use. The pan is to be water-tight and with a clevis and singletree hooked to each end runner with horses spread apart; it has a tendency to gather the hoppers into the pan and the idea of a long pan is to get over the most ground, quickly, with least travel. This improved pan is much less expensive than the hopperdozer ordinarily recommended, is much

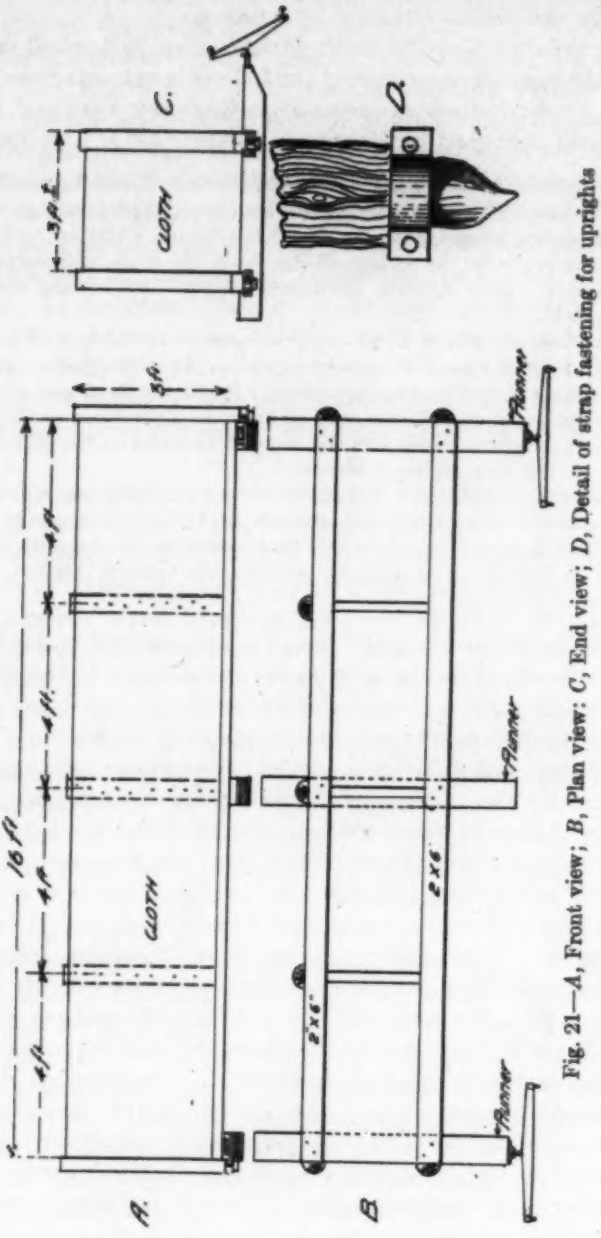


Fig. 21.—*A*, Front view; *B*, Plan view: *C*, End view; *D*, Detail of strap fastening for uprights

more easily constructed, and, as has been indicated, when not needed for use it can be folded up and put away until occasion requires its further use.

Entomologists will, the writer is confident, be interested in having a history of the origin of the "Criddle Mixture" by Mr. Criddle himself, and therefore no apologies are offered for including in this paper some notes on the Criddle mixture kindly sent to the writer by the originator of this, one of the least expensive and most useful and effective of our insecticide mixtures.

The origin of the grasshopper bait, christened by the late Doctor Fletcher, "Criddle Mixture," was due to an observation on the part of Mr. Norman Criddle that grasshoppers were in the habit of abandoning all vegetation in favor of freshly-dropped horse dung, this preference being so marked as to leave no doubt in the minds of even the most casual observers. Droppings left several hundred feet in the midst of growing grain at once attracted grasshoppers from the edges of fields so that they might be seen marching steadily towards the direction from which the odor came, and then, having speedily devoured the "droppings," they attacked the surrounding crop with the result that a large bare patch would be made in the midst of it. A few examples such as this seem in themselves sufficient evidence of the substances' attractiveness, but if more were needed the roads and manure piles amply verified what had been observed before.

"The second ingredient, salt, was also added through observation. It is well-known that clothing and the handles of any farm implement will attract grasshoppers on account of the salty taste, caused through contact with the human skin, while experiments supplementary to this observation showed that they readily ate any article steeped in salt water. For this reason salt was added and proved particularly valuable after the droppings became dry.

"The third ingredient was largely a matter of cost and convenience. Paris green, arsenic or arsenite of soda would doubtless prove equally successful as a killing agent, and Paris green was selected on account of its availability in sufficient quantity. After numerous experiments the following formula was adopted as most suitable:

Horse droppings, preferably fresh, by measure one hundred parts;

Paris green, one pound or part;

Salt, one pound or part."

"This approximates 15 gallons by measure of horse manure to one pound of Paris green and salt. It may be mixed in two ways, namely, dry with sufficient water added to make a thoroughly moist, but not sloppy, mash; or by placing the Paris green and salt in water first and pouring this over the 'droppings.' Before application it is necessary to pay some attention to weather conditions, cloudy days, or those in which the temperature is below 60° F., should be avoided and preference given to those in which sunshine and heat predominate. In applying it the best method seems to be to scatter it thinly among the grasshoppers every few days. It can, however, be put out in small heaps, in which condition its attractiveness lasts longer but it is more dangerous to stock.

"There is no doubt whatever as to the remarkable attractiveness of this mixture at all periods, from the time of the locusts' appearance in May until they die in September, or of its superiority over any other form of extermination yet tried in these parts. The evidence of farmers is almost unanimous on this point, and all the best type speak with enthusiasm of its value, the few exceptions being due to faulty methods in its application and mixture. My brothers and I have also used it con-

tinuously for the last ten years with perfect success and at very small cost, the last occasion being this season when we undoubtedly saved many acres of crop, while on more than one occasion its use undoubtedly saved the whole crop as was shown by the destruction of those not treated.

"This, however, refers only to Manitoba, as my experiences have been but casual outside, but I am of opinion that climatic conditions, particularly humidity, play an important part in the success or failure of this mixture. From a few observations made in Quebec some years ago, I found horse dung far less attractive there, and the roadways, which in Manitoba would be swarming with locusts, were comparatively free. Judging from this, I would expect to find it valueless in the moister parts of Canada and the United States, and most useful in the dryer Northern States, particularly the Dakotas, Minnesota and Montana, as well as Alberta, Saskatchewan and Manitoba.

"Why a mixture so attractive in Manitoba should prove useless in Quebec in a time of drought with the same species of grasshopper involved, is difficult to answer. That it is so there seems no doubt, and the problem is therefore to ascertain, with accuracy, what the conditions are and where the conditions are favorable or otherwise. I should consider a trustworthy indication would be to watch the freshly-dropped dung and roadway. When this is eaten freely, the mixture should prove a success, when grasshoppers are not so attracted, it will prove a failure.

"It may not be out of place to remark in conclusion that stable water from behind the stalls is even more attractive than dung and has proved a remarkable attractant when mixed with other material such as bran or sawdust, while grasshoppers have been observed to actually devour the earth in places where it has been left. Dry cow dung is also readily devoured."

While it will be observed from the foregoing that it has been entirely practicable to destroy from 75 per cent to 95 per cent of the grasshoppers present in given areas, thus showing that these methods perhaps offer the greatest protection to a majority of farmers and ranchmen, there are cases where, owing to a variation in existing conditions, other precautions must be taken. These insects deposit their eggs in waste lands, in many cases lands that owing to their nature it is impossible to bring under cultivation. Myriads of young are produced and develop in such breeding grounds and continue to migrate therefrom for a considerable period of time, so that the destruction of even 90 per cent of the grasshoppers present at any one particular time frequently does not offer entire protection to the farmer. Therefore other measures for destroying these pests must not be overlooked.

During the past season several owners of large areas in New Mexico tried discing, harrowing and other methods of shallow culture during fall or winter to destroy the eggs. Spring culture of this character will not destroy the eggs. While of course winter culture cannot be carried out in the northernmost part of the country, it is entirely feasible in many sections of the South, where grasshoppers prove a grievous pest. And in the northern part of the country many areas of waste land can be disced or harrowed or otherwise stirred in the fall to a depth of two or three inches.

One of the most striking examples of the advantages of this method that has come to our notice during the past season was in the case of a farmer in the vicinity of Wagonmound, New Mexico, who had made a practice of discing all his ditches, fence rows, and other waste places on an extensive alfalfa farm, as well as discing alfalfa itself. During the summer of 1915 there were very serious ravages of grasshoppers in that neighborhood but this farm almost entirely escaped grasshopper attack. If this were a single instance it might be termed a coincidence, but all through that country, where waste areas were treated in this way during fall or winter, it was very easy to pick out such later on during summer on account of the slight damage done by the grasshoppers.

The greatest objection to methods of this sort is, however, the difficulty in arranging for a thorough coöperation. If farmers over a considerable area would all combine and go over the waste lands where possible with disc harrows, or even other harrows, and cultivate to the depth of a couple of inches, they would derive a vastly greater benefit than would seem possible. In fact if this method of treating waste lands were followed during the fall or winter where possible, supplemented the following year by the use of poisoned baits, it is doubtful if any one need suffer seriously from the attacks of grasshoppers in any section of the United States.

SOME STUDIES ON THE SNOWY TREE-CRICKET WITH REFERENCE TO AN APPLE BARK DISEASE

By P. J. Parrott, W. O. Gloyer and B. B. Fulton

Recent years have been characterized by great activity in the study of insects as carriers of human and animal diseases. A cursory perusal of literature suggests that much less attention has been directed to the rôle that these agents play in the dissemination of disorders of plants. Observations of the snowy tree-cricket (*Œcanthus niveus* D.G.) on apples have indicated that the investigation of the activities of this species on this host would prove a fruitful problem for study and furnish a contribution to the knowledge of this somewhat neglected field.

One who has noticed the work of *Œ. niveus* on apple can hardly fail to form the opinion that this species is in some way connected with the spread of a bark disease of this fruit. Even to superficial observations, that there is a relationship between this insect and some parasitic organism, is plain and unmistakeable. The opinion that there is some such association is formed from the fact that the tissues about

the wounds in the bark produced by the insect are much discolored or dead. The diseased areas range generally from one-fourth of an inch to an inch in diameter, while the bark within these limits varies from purplish or reddish-brown to pale brown, depending apparently on the extent and age of the infection. Usually most of the affected spots are circular or somewhat oval in form, and occasionally there is a large irregular extension of the original infected area as if there had been a renewal of activities by the infectious agent. The bark within the area of infection is generally slightly depressed and may also be separated from the sound bark by a distinct line or narrow crack. In more advanced stages cracks develop, separating the dead area from the surrounding living tissues, and there is formed a core which adheres loosely to the wood, affording attractive situations for the woolly aphis. From the wounds made by the insect, located as a rule in the center of the diseased areas, one may observe in April or May more or less flowing of a gummy, reddish-colored liquid, which on drying leaves a resinous product about the orifices of the punctures. In their external appearances and effects these cankers resemble superficially certain stages of the New York apple-tree canker (*Sphæropsis malorum* Pk.) or the blight canker of apple trees (*Bacillus amylovorus* (Burr.) de Toni).

Our investigations on the tree cricket with reference to this disorder of apples have been along three lines, (1) to identify the infectious organism of the apple bark, (2) to ascertain the habits of the tree cricket to determine in what ways it may act as a carrier of the disease and (3) to make experimental attempts to reproduce the disease in apples by using the crickets as carriers of the spores. These studies were conducted jointly by the Departments of Botany and Entomology of the Geneva Station, the former department directing the work involving the determination of the fungi and the cultural and experimental operations with the disease organisms.

Identification of Causal Agent of Bark Disease

The primary steps in this coöperative effort involved the determination of the causal organism, which was essential before there could be a really intelligent understanding of the exact rôle of tree crickets in the dissemination of the disease. Cultural and microscopical studies conducted to this end have revealed the interesting fact that the causal agent of the bark trouble in New York was, in the majority of cases, neither the New York apple canker (*Sphæropsis malorum*) nor the fire-blight canker (*Bacillus amylovorus*), as formerly supposed, but a species known as *Leptosphæria coniothyrium* (Fckl.)

Sacc. (*Coniothyrium Fuckelii* Sacc.). According to Duggar[1] this is a fungus which, as a disease-producing organism, has been known only a few years. O'Gara[2] lists it as occurring on apple and rose at Washington, D. C., and on apples in a nursery near Clemson College, S. C. It is stated by this writer that most of the infections took place where the bark of the trees had been bruised or slightly broken by the tools or harness in cultivating. He also records that in one nursery serious infection was found on apple trees which adjoined a clump of wild roses badly infected with the disease. The trees nearest the roses showed the greatest number of infections. In New York this fungus had, up to the time of this investigation, attracted no attention either as an apple or as a rose pest, but since 1899 it has been regarded in this state as a widespread and serious disease of raspberries, which is known as Raspberry Cane Blight. It is essentially a wilt disease, and the principal damage results to the fruiting canes. The whole cane may be involved or only a portion of it. As to the manner of infection Clinton[3] thinks that the fungus gains entrance through the flowers and fruit, the spores being apparently spread by bees and other insects. Stewart,[4] as a result of his extensive and careful studies of the disease, believes that infection occurs in wounds of various kinds and that a break in the epidermis usually precedes the attack. He also states that cane-blight often starts in wounds made by the "heading back" of new canes, by the removal of branches, by the rubbing of canes against each other or against supporting wires, and particularly in crotches where the branches are more or less split apart, and in wounds made by the snowy tree-cricket *Œcanthus niveus* (*nigricornis*) during oviposition. "The wounds thus made furnish a lodging place for *Coniothyrium* spores and also for water necessary to the germination of the spores, making the conditions exceptionally favorable for infection. That infection does actually occur in tree-cricket wounds is shown by the large number of instances in which the cane is covered with *Coniothyrium* pycnidia in the vicinity of the wounds, usually just below them. The well-known tendency of cricket-injured canes to break at the point of attack is probably due, in part, to brittleness induced by the *Coniothyrium*. It appears that the injury done by the tree cricket is often much aggravated by the cane-blight fungus. While *Coniothyrium* often takes advantage of wounds it is by no means certain that it should be classed as a wound parasite." As to the methods by which it is distributed, Stewart suggests the dissemination

[1] Duggar, B. M., Fungous Diseases of Plants, p. 354.
[2] O'Gara, P. J., Phytopathology, Vol. 1, p. 100, 1911.
[3] Clinton, G. P., Conn. Exp. Sta., Report (1906): 321–324.
[4] Stewart, F. C., N. Y. Ag. Exp. Sta., Bul. 226, pp. 331–366.

of infested plants through the nursery trade and the carrying of spores by wind and rains, or by pickers or workmen in pruning the vines. The suggestion is also made that birds and insects carry the spores to a limited extent. The fact that the blight is so abundant and destructive to raspberries and that, while the tree crickets occur in great numbers on raspberries, they prefer apple wood for oviposition is additional presumptive evidence, tending to support the theory that these insects have a hand in infecting apple trees with the disease.

Certain Habits of Tree Crickets which Favor Dissemination of the Bark Disease

In the absence of definite data as to the actual part played by the insects in the dissemination of this trouble, it appeared from the start that two habits of tree crickets should be carefully studied, which are, (1) their feeding habits, and (2) their oviposition habits. Tree crickets are omnivorous creatures and subsist on a diet of wide assortment. In their early life they feed extensively on plant lice, leaf-hoppers, tingitids and scale insects. At times they also exhibit cannibalistic tendencies, directing their attacks to the tips of the folded wings or to portions of the abdomens of one another, while those offering feeble resistance may be devoured outright. As the insects approach the mature stage, they develop more pronounced phytophagous and mycophagous habits, feeding on the floral organs of various plants, on foliage, on fruits of different sorts, and such minute fungi as may be found on bark or decaying vegetation.

The snowy tree-cricket oviposits in a great variety of plants, among which may be mentioned apple, plum, cherry, walnut, raspberry, elm, peach, witch hazel, chestnut, butternut, wild crab-apple, hawthorn, red oak, maple and lilac. The largest numbers of eggs have so far been found in apple, plum, cherry and elm. The areas selected for the reception of the eggs varies according to the variety of plant and the age of the wood. With the raspberry, the eggs are inserted at the sides of the buds in the fleshy parts in the axils of the leaves but they do not extend into the pith, while with the elm the eggs may be most commonly observed in the corky areas and they do not as a rule reach the soft inner bark. In the case of other trees, especially the apple, deposition on the smaller branches occurs about the thickened bark at the bases of the twigs. With older wood, the eggs may be found about all areas of the bark, and frequently they are inserted through the lenticels and are placed in the inner soft bark. In making a hole for the reception of the egg a groove is sometimes cut in the surface of the underlying wood, but the female generally avoids drilling to any appreciable distance in such hard structures.

The process of egg deposition is briefly as follows: The female, having selected a suitable spot on the tree, first gnaws a hole in the bark. She then advances forward, and moving the ovipositor at right angles to her body, inserts the tip of it in the wound and proceeds to bore the hole for the reception of the egg. The drilling is accomplished by a thrusting and rotating motion of the ovipositor. After boring to a suitable depth, the egg is deposited. An adhesive substance is then discharged, which is kneaded about the egg by the ovipositor. Attention is also called to the curious habit of the female which, at the conclusion of the drilling operation, usually defecates and then, when the egg is deposited, conveys the excreta by means of her mouth to the wound and gently kneads it to form a neat cap to the opening.

In studying the feeding and oviposition habits of the snowy tree-cricket it appears that infection of apple bark might take place as a result of (1) wounds produced by the gnawing of the bark by the female as the initial step in the act of oviposition; (2) by means of the ovipositor, the adhesive substance discharged at the time of deposition, serving to collect and to hold the spores which may later be left in the holes during the drilling process; and (3) by the introduction of spores in the oviposition wounds on account of the remarkable habits of the insect, which employs its excreta to close the openings in the bark after the deposition of the egg. Our attention has largely been devoted to the consideration of the last point, which has involved a study of the viability of the mycelia and spores of fungi after passage through the intestinal tract of a number of the crickets and experiments in the orchard using tree crickets as carriers of the spores of several of the more important bark diseases of the apple.

In our work to determine the effects of the digestive processes of the insects upon the vitality of the spores the following methods were employed: Tree crickets to the number of twelve to twenty individuals were confined in breeding cages containing raspberry shoots and apple twigs which were abundantly infested with plant lice. Spores of various fungi were introduced into the breeding cages in a 5 per cent cane-sugar solution which was atomized over the foliage or through sections of wood which were affected by some of the common bark diseases. At varying intervals of time microscopical and cultural studies were made of the excreta to classify the different species of spores in the alimentary wastes and to determine their viability in ordinary agar cultures.

Some of the more interesting results obtained in these tests may be briefly summarized as follows:

1. The crickets fed readily on diseased areas of apple and raspberry canes, even when foliage and lice were abundantly

supplied. In one cage containing cankers of the New York apple canker, *Sphæropsis malorum*, and spores of the blister canker *Nummularia discreta* Tul. applied to foliage, an examination of fifty pellets showed twelve pellets without spores of either fungus; twenty-eight pellets with spores of the New York apple canker, and twenty pellets with spores of the blister canker. In many instances spores of both diseases were found in the same pellets.

2. When crickets were starved two days before feeding, spores of various fungi passed through the intestinal tract in a period of six and one-half hours.

3. When tree crickets were allowed to feed normally before the tests, spores of various fungi, including the New York apple canker and blister canker, were found in the excreta four days after diseased wood was removed from their diet.

4. Cultural tests of spores in the excreta showed that spores of the New York apple canker and the Mica Inky Cap (*Coprinus micacious*) passed unharmed through the intestinal tracts of the crickets. Spores of the blister canker showed poor germinating qualities. The feeble growth of the stock cultures suggests that the spores possessed low vitality, which may be explained by the fact that they were taken from museum material nearly one year old. The excreta of these insects possess a rather extensive flora, which includes such forms as *Penicillium*, *Alternaria*, *Pestalozzia*, *Asperillus*, a *Myxomycete*, and many bacteria and yeasts. Most of these showed a high rate of germination after being subjected to the digestive processes of the tree crickets.

5. In twelve attempts to establish the New York apple canker, the *Coniothyrium* canker and brown rot (*Sclerotinia fructigena* (Pers.) Schrœt.) in peaches and apples, all proved failures except in one experiment where there were three slight infections by the *Coniothyrium* canker. On account of the readiness with which the insects feed on the spores and the abundance of these organisms in the excreta, it would appear from the work already accomplished that conclusive experimental proof of such carriage of bark diseases ought not to be difficult to demonstrate, especially with a better understanding of the conditions favoring inoculation and incubation, to which plant pathologists are now devoting considerable attention.

While the foregoing data dealing with the viability of spores of various bark diseases after passage through tree crickets are new, it should be stated in conclusion that the existence of pathogenic microörganisms in the digestive tract of insects and their degrees of resistance to the

digestive processes of various forms of animal life have been discussed by other writers. House-flies captured in the open are said to show a great variety of spores. Dr. Graham Smith states that feces, deposited by flies, contain organisms in considerable numbers for at least two days after feeding by the insects and that they are frequently infective for much longer periods. Anthrax spores, according to this writer, survive for many days on the exterior of the insect as well as in the alimentary canal. Some writers maintain that the danger of disease germs that pass through the body of the common house-fly is greater than from those supposed to be carried from foul substance on their feet. Studies on the *Fusarium* rot of corn showed that the germinating powers of this disease were little or not affected when subjected to the digestive processes of chickens. The studies by Morse on potato scab indicated that the spores of this disease are able to pass through the digestive tract of both horses and cows and go into the manure pile without being destroyed, but much more readily with the former than the latter. The manure of horses is very likely to carry the germs of this disease. Similar views are held by plant pathologists generally with respect to corn smut, cabbage club-root, and other plant diseases.

A NEW SPECIES OF GONATOCERUS (MYMARIDÆ) PARASITIC ON THE EGGS OF A NEW SPECIES OF IDIOCERUS (BYTHOSCOPIDÆ) FEEDING ON POPLAR

By M. D. Leonard and C. R. Crosby, *Ithaca, N. Y.*

On May 29, 1914, a resident of Ithaca brought to the Insectary some poplar branches badly infested with nymphs of a Bythoscopid. No further opportunity was presented for the study of the insect until the spring of 1915 when, on April 1, we procured some small branches from the infested trees and placed them in water in a warm room in order to force out the buds. The eggs began to hatch on April 19 and the first adults were obtained on May 14. The insect was at first thought to be *Idiocerus alternatus* Fitch but, owing to discrepancies between the life history of that insect as described by Osborn and Ball (Iowa Agr. Exp. Sta. Rept. for 1897, p. 118) and the life history of the species under discussion, we were led to question the determination. Prof. Herbert Osborn has kindly compared our specimens with those in his collection and informs us that he is of the opinion that they represent an undescribed species.

Idiocerus gemmisimulans new species.

Female. Length, 7 mm. Vertex yellowish with a dark brownish irregular line connecting the eyes along the crest; the usual spots on the vertex indicated by two small more or less indistinct brownish dots; vertex mottled with brownish, especially at the inner upper angle of the eye and in the center where it is more or less bluish in certain lights. In the darker specimens a broken irregular dark brownish procurved line connects the antennæ. Ocelli situated on dark brownish spots. Face pale yellowish. Sculpture of vertex finely, transversely rugulose. Basal segment of antennæ yellowish, second segment blackish, remainder yellowish to dark brownish. Prothorax with bronzy reflections, brownish, sometimes mottled with bluish, transversely rugulose; sculpture more pronounced than on the vertex. Scutellum brownish, paler behind, rugulose in front of the depressions and transversely striate behind. Wings pale brownish, veins with alternating dark brown and white portions. When the wings are at rest the following white portions of the veins are most conspicuous: terminal portion of *2d A* (which when the wings are closed makes in combination with the white vein on the opposite wing a conspicuous V-shaped mark); a section near the base of *Cu* opposite the fork of *R;* the fork of *R;* and the junction of *Cu2* and *1st A*. Legs brownish yellow; tibiæ with a more or less distinct dark brownish stripe extending along the basal half of the outer edge. Claws blackish. Ventral aspect of insect yellowish.

Male (Pl. 30, Fig. 6). Length, 6 mm. Coloration of head similar to that of female. Prothorax slightly more grayish with two irregular blackish spots in center and one on either side on posterior border. Scutellum yellowish brown with a blackish bar in front notched in the center behind, and nearly interrupted by two large areas of the ground color, behind this bar are two small blackish spots. Membrane of wings for the most part pale brownish, more pronounced at tip, veins with alternating whitish and dark brownish or blackish portions. The extent of the dark brownish portions on the wings varies to a considerable extent but is often as shown in Pl. 31, Fig. 10. The markings on the wings are more distinct than in female. Antennæ and legs similar to those of the female. Antennæ without discs. Face of the male (Pl. 31, Fig. 9) similar to that of female. In the lighter specimens the mottling on the vertex, which in the darker specimens often forms a more or less distinct band connecting the eyes, is very faint, and the procurved line connecting the antennæ lacking.

Egg (Pl. 30, Fig. 7). Length, 1.36 mm., width, .4 mm., bluntly rounded at posterior end, tapering gradually to anterior end which is obliquely truncate and provided with a dark brownish cap; pale translucent, shiny; chorion finely punctate.

The eggs (Pl. 31, Fig. 8) are inserted in groups of five to ten, eight being a common number, just under the bark of the green twigs, usually just above a bud. The eggs lie flat in a more or less curved row under a thin flap of bark which soon turns brown.

NYMPHS.

Stage I (Pl. 30, Fig. 1). Length, 1.29 mm., width of head including eyes, .63 mm. General color shining dark brown or black. Head with a narrow yellowish median line. Thorax with a broader yellowish median line of varying width. First and second abdominal segments yellowish; the latter brownish laterally. Eyes reddish. Antennæ pale yellowish, except basal segment which is black. Coxæ, trochanters and extreme base of femora pale yellowish; remainder of femora and basal half of tibiæ dark brownish or blackish; terminal half of tibiæ and first tarsal segment pale yellowish; whole of second segment of fore tarsi, and tip of second segment of middle and hind tarsi, blackish; claws blackish.

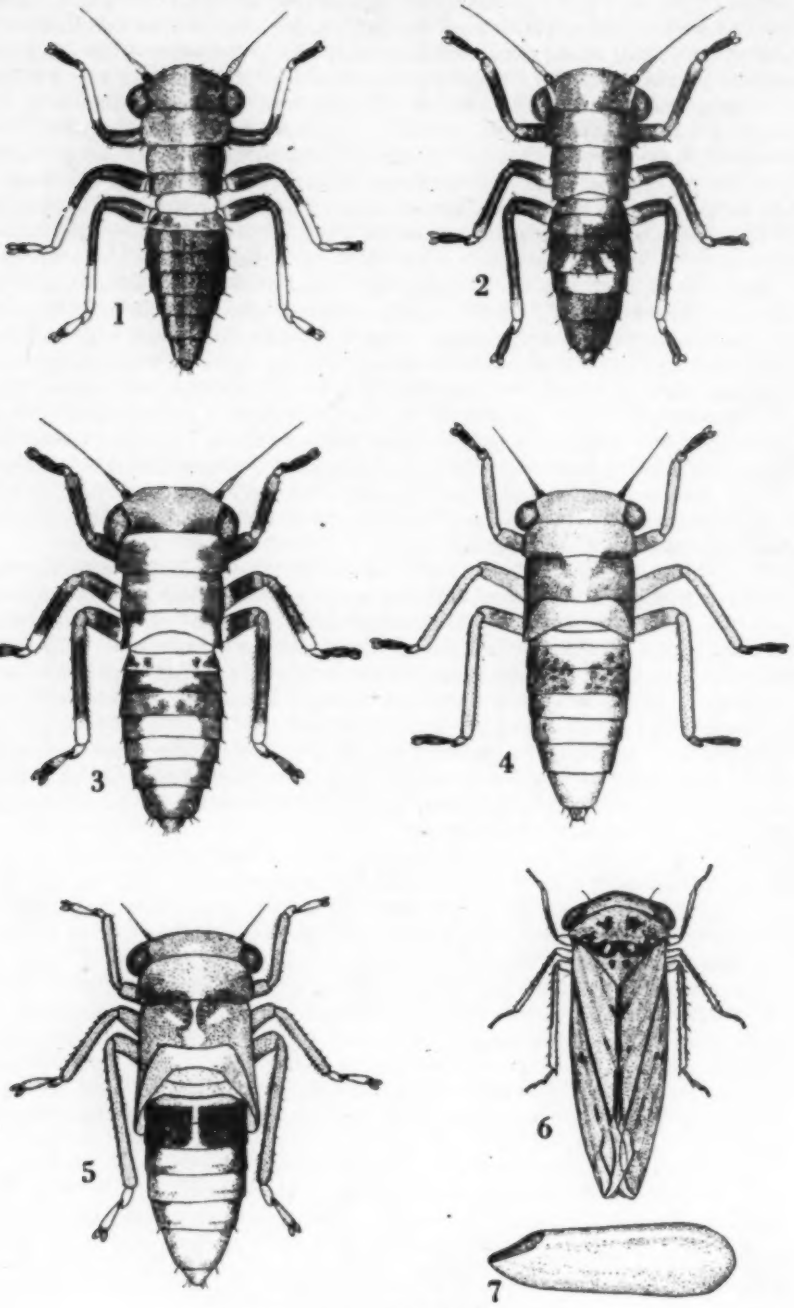
Stage II (Pl. 30, Fig. 2). Length, 1.98 mm., general color dark brownish to blackish. A pale yellowish median stripe, varying in width, extends from near the vertex back to the middle of the third abdominal segment. Segments five and six of abdomen yellowish in center. These yellowish markings vary considerably in extent and distinctness in different individuals. There is also a pale yellowish line on the head bordering the inner margin of the eyes. Eyes reddish. Antennæ pale yellowish except basal segment which is blackish. Coxæ, trochanters, extreme base of femora and tip of middle and hind tibiæ pale yellowish or whitish. Tip and base of fore tibiæ and tip of fore femora light brownish. First segment of tarsi whitish or slightly tinged with brownish; second segment of tarsi blackish; claws light brownish.

Stage III (Pl. 30, Fig. 3). Length, 2.61 mm., width of head including eyes, .85 mm. In this stage the general color is somewhat lighter than in the two preceding stages and the yellowish median stripe is considerably broader. It varies in extent and width but is usually about as shown in the figure. Head wholly tinged with brownish, with dark brownish or blackish on caudal margin inside eyes. Eyes and antennæ as in preceding stage. Legs dark brownish or blackish except for the following parts: coxæ, trochanters, extreme base of femora, and tip of middle and hind tibiæ and first tarsal segment, pale yellowish; tip of fore tibiæ, tip of femora, base of tibiæ, center of second tarsal segment, and the claws, light brownish. Metathoracic wing-pads extend back to second abdominal segment and mesothoracic wing-pads noticeably produced backward.

Stage IV (Pl. 30, Fig. 4). Length, 3.88 mm., width of head including eyes, 1.57 mm. Markings variable but in general as shown in figure. Paler than in preceding stage being rather light brownish. Head pale brownish. Median yellowish area broad on prothorax, narrowing on mesothorax, then wider on metathorax. Laterad of this area on the pro- and metathorax pale brownish, on mesothorax dark brownish. Abdomen with two large yellowish areas narrowly connected on the median line, bordered laterally with dark brownish. Eyes and antennæ as in preceding stage. Legs yellowish brown, femora paler at base and tip. Fore tibiæ tinged with dusky except at base. First tarsal segment yellowish tipped with dusky; second segment dark brownish or blackish, lighter in middle; claws brownish. Wing-pads extend back nearly to third abdominal segment.

Stage V (Pl. 30, Fig. 5). Length, 4.9 mm., width of head including eyes, 1.98 mm. Head pale brownish. Prothorax yellowish or brownish yellow, hind angles darker; mesothorax brownish except a yellowish median portion and a yellowish spot on either side of this, as shown in figure. Metathorax yellowish in center as in preceding stage; wing-pads pale brownish. First two segments of abdomen brownish yellow, remainder of abdomen yellowish except the lateral margins of segments five to nine which are dark brown and a blackish band interrupted narrowly along the median line and including the posterior two-thirds of segment three and the whole of segment four. Antennæ and eyes as in preceding stage. Legs light brownish; first segment of tarsi yellowish, second segment at base and tip, and the claws, tinged with brownish. Wing-pads extend back to middle of fourth abdominal segment.

Until about the fourth stage the nymphs remain feeding on the leaves. In the fourth and fifth stages they are found on the smaller twigs resting usually with the head directed towards the base of the branch. In this position they bear a striking resemblance, both in form and color, to the buds of the poplar.



Idiocerus gemmisimulans

Described from thirty-four adult specimens—thirteen females and twenty-one males. Reared on the common poplar, *Populus deltoides* Marsh, and from Lombardy poplar, *Populus nigra italica* Du Roi, at Ithaca, N. Y. The descriptions and drawings of the nymphal stages were made from living specimens. Types in the Cornell University collection.

This species is most closely related to *I. lachrymalis* Fitch, from which it may be distinguished by the fact that the antennæ of the males lack discs, the absence of the spots on the face, the less distinct spots on the vertex, and the presence of a blackish line on the tibiæ.

THE EGG-PARASITE. On May 20 it was noticed that parasites were emerging from the eggs of Idiocerus through a small round hole in the bark overlying the egg-clusters. Six specimens were secured of which four were females and two males. This species is apparently undescribed.

Gonatocerus ovicenatus new species.

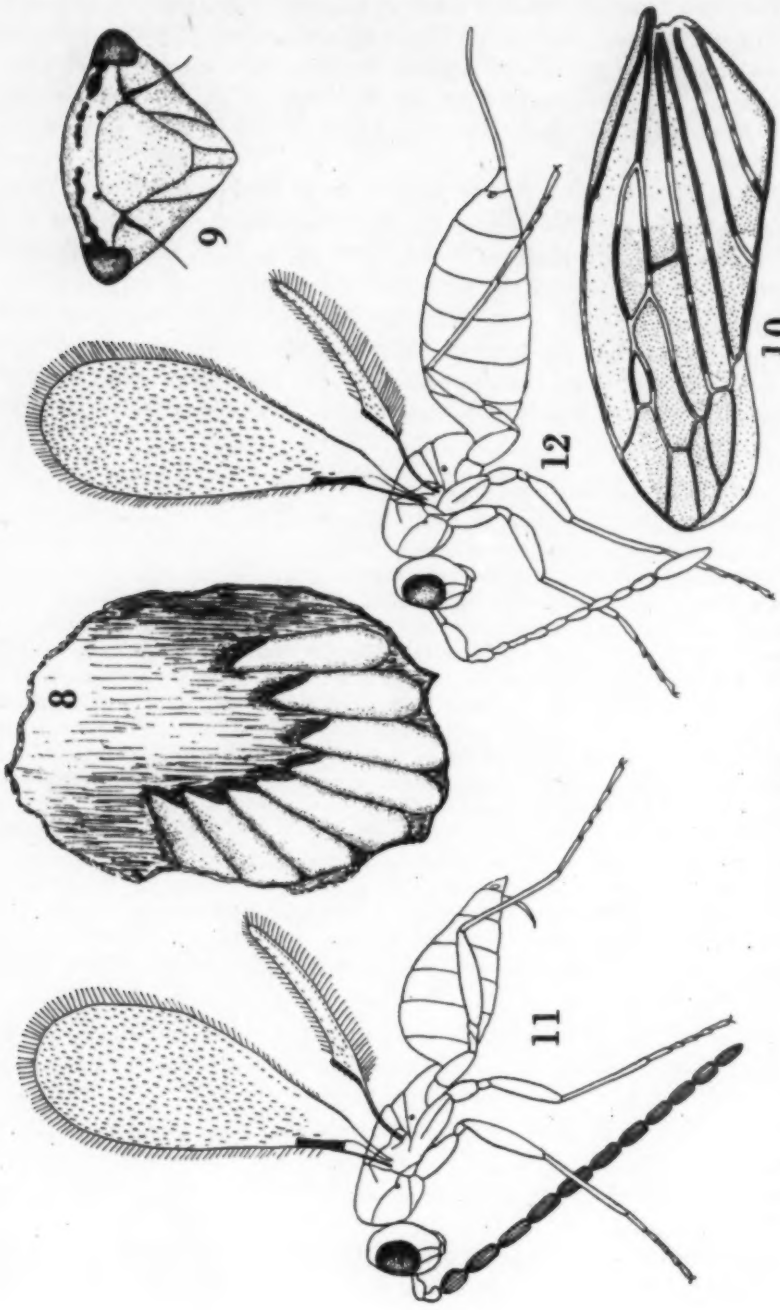
Female (Pl. 31, Fig. 12). Length, 1 mm., ovipositor, .36 mm. General color black, the eyes dorsally and posteriorly narrowly margined with white. A broad band on the vertex connecting the eyes and including the ocelli, whitish. Thorax and abdomen uniform black. Ovipositor black, distal third bent slightly downward. Antennæ brownish, radicula slender, one half as long as the scape. The scape is compressed, widened below, the articulation with the radicula marked by a whitish band; pedicel obconic. The relative length of the segments of the antennæ is indicated by the following ratio: radicula and scape, 36; pedicel, 18; funicle segments 10, 12, 16, 15, 18, 17, 16, 16; club 40. Legs blackish, base and tip of front femora, front tibiæ, and tarsi of all the legs paler; terminal tarsal segments darker than basal segments. Wings hyaline. Front wing one-third as wide as long. Length of longest marginal cilia about one-fifth width of the wing.

Male (Pl. 31, Fig. 11). Length, .9 mm. In color similar to the female. Whitish markings on the head as in the female. Antennæ brownish, thirteen segmented. The relative length of the segments of the antennæ is indicated by the following ratio: scape 15; pedicel, 10; funicle segments, 20, 25, 24, 20, 22, 25, 25, 25, 22, 23, 22. Scape short, rounded below; pedicel broadly obconic; first funicle segment broader than succeeding segments; the segments of the funicle coarsely ridged longitudinally.

Described from four females and two males, reared at Ithaca, N. Y., from the eggs of *Idiocerus gemmisimulans* Leonard and Crosby, May 20, 1915. Types in the Cornell University collection.

According to Girault's table to the species of Gonatocerus (Trans. Am. Ent. Soc., 37: 273), this species would run fairly well to *G. maga* Girault, from which it may be distinguished by the antennal characters given above.

Our thanks are due to Professor Osborn for examining our specimens of Idiocerus and comparing them with specimens in his collection.



Idiocerus and Gonatocerus

EXPLANATION OF PLATES 30 AND 31

Fig. 1. Idiocerus gemmisimulans, first stage nymph.
Fig. 2. Idiocerus gemmisimulans, second stage nymph.
Fig. 3. Idiocerus gemmisimulans, third stage nymph.
Fig. 4. Idiocerus gemmisimulans, fourth stage nymph.
Fig. 5. Idiocerus gemmisimulans, fifth stage nymph.
Fig. 6. Idiocerus gemmisimulans, adult male.
Fig. 7. Idiocerus gemmisimulans, egg.
Fig. 8. Idiocerus gemmisimulans, cluster of eggs in position.
Fig. 9. Idiocerus gemmisimulans, face of male.
Fig. 10. Idiocerus gemmisimulans, wing of male.
Fig. 11. Gonatocerus ovicenatus, male.
Fig. 12. Gonatocerus ovicenatus, female.

THE POISONOUS EFFECTS OF THE ROSE CHAFER UPON CHICKENS

By G. H. LAMSON, JR., *Storrs, Conn.*

Serious losses have occurred each year during June and early July, from chickens having eaten the rose chafers (*Macrodactylus subspinosus*). These losses have often been ascribed to various causes but close observations have shown that the chickens are very fond of eating the insects and post mortem examinations have revealed the presence of many undigested rose chafers in their crops. The crops are usually so full as to give the impression that death had been due to a "crop-bound" condition of the chickens. Some have also supposed that these deaths were due to a mechanical injury of the crop by the spines on the legs of the insects having punctured the lining of this part of the digestive system while others have accounted for the death of these chickens by the rose chafers having bitten the crops.

A number of cases, some of which resulted in the loss of several hundred chickens, were reported to the writer and experiments in feeding rose chafers to chickens were taken up at the Storrs Agricultural Experiment Station in 1909.

The deaths from this diet usually occurred in from nine to twenty-four hours after feeding. This led the writer to believe that undoubtedly death resulted from a cause other than a mechanical injury to the crop or "crop-bound" condition. An extract was made from crushed rose chafers and distilled water, filtered, and fed to chickens in varying doses with a medicine dropper and this resulted in a great many deaths. Small chickens died in a few hours after feeding, older chickens of heavier weight, when fed a small quantity of the extract, lived but showed signs of poisoning; large doses resulted in their deaths. Mature hens did not die from the poison.

From 150 to 200 chickens have been fed either with the rose chafers

or with varying strengths of the extract to determine the weight of the chicken killed by a certain amount of poison, also to determine the age limit of the chickens killed.

The results may be summarized as follows: 15 to 20 rose chafers are sufficient to cause the death of a chicken a week old. From 25 to 45 rose chafers are usually necessary to kill a three-weeks-old chicken. While some nine-weeks-old chickens have been killed by eating rose chafers, only one ten-weeks-old chicken was killed in these experiments. In the crop of this chicken there were 96 undigested rose chafers counted in post mortem examination.

The chickens feed upon the insects ravenously, being attracted by their sprawly appearance and usually within an hour after eating they begin to assume a dosing attitude, later leg weakness shows and the chicken usually dies within 24 hours of having eaten upon these insects, or begins to improve after this time.

In less than five per cent. of the deaths convulsions occurred. Post mortem examinations showed no abnormal condition of the organs. In order to exclude the possibility of arsenical poisoning due to the rose chafers having probably fed upon leaves that had been sprayed, tests were made by a chemist for arsenic, but no evidence of arsenic was found. Intravenous injections also were made in these experiments, extracts for injection being made from forty grams of rose chafer and sixty grams (cc.) of a salt solution having a specific gravity of .9 per cent. This extract was put in a centrifuge for five minutes, the extract drawn off in a pipette and filtered in vacuo.

Three cc. of this extract was injected into a 690 gram rabbit intravenously and this died in six minutes. Another rabbit, weighing 1,435 grams, died after an injection of four cc. of this extract in three and one-quarter minutes. A small 610 gram rabbit, when injected with two and one-half cc., died in fifty-five seconds after injection, and a large 1,450 gram rabbit died in two hours and thirty-five minutes after being injected with two cc. Other rabbits were injected and killed by this extract but further work needs to be done to determine what is a lethal dose for rabbits and also experiments in feeding rabbits per os will be taken up next summer.

As near as the writer can determine, the rose chafers contain a neuro toxin, that has a direct effect upon the heart action of both chickens and rabbits and is excessively dangerous as a food for chickens.

Owing to the fact that the insect feeds upon such a large number of plants it seems essential that chickens be kept in mowed fields and away from yards having grape vines and any flowering shrubs during the month when rose chafers are most numerous, especially during years when rose chafers are particularly abundant.

Scientific Notes

Cyllene robiniæ and Crioceris in Colorado. I regret to have to record the appearance in Boulder, Colo., of two pests which I have not observed before, and which have presumably been very recently introduced. Three times, during September and October of this year, I have picked up specimens of *Cyllene robiniæ* Forst., which have been crushed on the pavement by the feet of the passersby. Also this fall my wife has twice found specimens of *Crioceris asparagi* L. in the bags covering sunflower heads. They must have come from adjacent patches of asparagus.

T. D. A. COCKERELL.

The Edibility of Insects. Very little has been done recently toward testing the edibility of many species of very abundant insects which theoretically must have a very positive food value, but at my suggestion Mr. J. J. Davis and Mr. D. G. Tower at La Fayette, Ind., have recently experimented to some extent with the eggs and larvæ of Lachnosterna. They find that Lachnosterna eggs crisply fried in butter are excellent, having a taste very much like a fine grade of bacon. The larvæ, fried in butter and eaten with bread in the form of a sandwich, were not at all disagreeable, having a fresh fatty taste. They ate the heads and all, and the heads were crisp and caused no inconvenience. This line of experimentation seems to me very well worth while, and field agents having the opportunity and disposition are urged to experiment in this direction when it can be done easily and without loss of time.

L. O. HOWARD.

An Eriococcus on Gaylussacia. Some time ago we received from Dr. E. P. Felt specimens of an *Eriococcus* on twigs of *Gaylussacia*, collected at Hammond, N. Y. The pure white female sacs are of the usual form, 2.25—2.50 mm. long. The surface rough with protruding filaments; female in sac bright red (in *E. azaleæ* it is dark purple, almost black); larvæ bright raspberry red. The following measurements in microns are from the adult female: antennal joints, (1) 43–45, (2) 23–25, (3) 35–38, (4) 28–30, (5) 13–15, (6) 13–15, (7) 28; middle leg, trochanter and femur, 115, tibia, 80, tarsus, 105, claw, 28. The caudal lobes are prominent, about 88 long, with bristles about 112. Bristles of anal ring 68 long; average dermal spines about 40. There is a denticle near apex of claw. This insect is quite distinct from those previously recorded from the Eastern States and from Europe, but we find it impracticable to separate it from the western *E. borealis* Ckll., except as a rather small variety. *E. borealis* is known from the Alaskan region down the Rocky Mountains to New Mexico and it is not surprising to find it in New York state. It feeds on several species of woody plants.

T. D. A. COCKERELL and ELIZABETH ROBINSON.

Soft Maple Leaf Midge (*Rhabdophaga aceris* Shim.). This species establishes itself in the unfolding, succulent leaves of the white or soft maple, preventing the normal expansion of the affected lobes and when there is a serious infestation, one or more lobes of the affected leaves may curl and die. The full grown larvæ are stout, yellowish-white or yellowish-orange, especially anteriorly, and about 2 mm. long. They occur mostly on the tip of the leaf, lying along the principal or lateral veins of the lobes. The probabilities are that the midges oviposit on the unfolding leaves or at least the tips of the leaves. Infestation is presumably favored by conditions producing a rapid, succulent growth. Pupation is on the leaf, in a yellowish-brown, irregularly oval cocoon about 1.5 mm. long. The final transformations are rapid, probably being completed within 48 hours and possibly within 24 hours.

This insect has been unusually abundant in the vicinity of Albany and has caused material injury in the case of small trees. It has also been reported to us the past summer by Mr. S. B. Fracker from northwestern Iowa and as very common in southeastern Wisconsin. Watching for the earliest signs of injury to the developing leaves and prompt spraying with a contact insecticide is the most promising method of controlling the midge. E. P. FELT.

The Desirability of Host Labels for Parasites. Recently, while looking over a systematic paper prepared by one of the parasitologists of the bureau, I noted that the data concerning hosts which accompanied the description were sometimes lacking and generally insufficient. For many years I have kept a card catalog of the recorded host relations of parasitic Hymenoptera, and a duplicate of this card catalog is now in the hands of Mr. Harry S. Smith of Sacramento, who is arranging it for possible publication under our joint authorship; and this is the reason why I have especially noticed this point. When field workers send in parasites for determination, many of which will of course be new to science, it is of great importance from my point of view that host labels should accompany the specimens. Of course a biological number referring to "Webster Notes" or "Hopkins Notes" or "Bureau Notes" will eventually enable some one to find out the facts concerning the host insects, but it is perhaps too much to expect of a systematic worker that he write for these data to headquarters, or to the field men, since often field notes are not sent in for months, and it frequently happens that the systematist is desirous of publishing immediately. Further the mere name of the host is not sufficient, but the stage should also be mentioned; that is, whether the parasite issued from the egg, from the larva, or from the pupa of the host. L. O. HOWARD.

Gall Midges in an Orchard. Observations on a quiet, lowery morning in a Baldwin orchard at Spencerport, N. Y., July 29, 1915, revealed an interesting condition in that thousands of small midges, a species of Parallelodiplosis, were to be seen hanging from spiders webs. The webs were rather common at the base of the larger branches, in a few instances had a transverse diameter of six or seven inches, and were composed of several layers or series of webs, the latter separated from each other by a distance of half an inch or more. It was easy to find series of five or ten midges on strands of the smaller webs, the insects being about one-fourth of an inch apart, arranged in rows, swaying freely with gentle breezes, and mostly on the lee side of the trees. The tendency of the midges was to alight side by side as nearly as they could without disturbing adjacent insects, and the regular arrangement was determined by the plan of the web, the flies naturally resting upon the larger, stouter threads. It was not uncommon to find hundreds, and in a few cases six or eight hundred of these midges upon the larger webs, and in the case of the latter they might be four or five deep, due to the several layers of the web offering attractive resting places. The small flies were timid and easily disturbed, though with care it was possible to approach within two or three feet without alarming many of the insects. On being disturbed, the midges would swarm about their haunts for a brief time and then slowly return in much the same way as commonly observed among flocks of birds. There was no evidence to show that the spider architects preyed to any considerable extent upon the midges, though the latter were far more abundant than any other form of life. A few midges were observed resting upon the trunk, especially clinging to fragments of webs, though retreats of this character were distinctly less favored by the insects.

This appears to be a fairly common habit among the smaller gall midges, at least, and similar observations in regard to several species and genera have already been put on record. E. P. FELT.

Another Nodule-Destroying Beetle. Records of insect larvæ which destroy the root nodules of legumes are apparently scarce. In addition to the Chrysomelid, *Cerotoma trifurcata* (pp. 261–266), it seems worth while to record an Otiorhynchid, *Eudiagogus rosenschoeldi* Fahrs. Late in August, 1913, the writer found that the nodules on the roots of *Sesbania macrocarpa* growing at Greenwood, Miss., were injured, but the insect which caused the damage was not present. The injury to the nodules was characteristically different from that caused by *Cerotoma*, and in view of the fact that adults of *Eudiagogus rosenschoeldi* had been previously observed feeding on the foliage of this plant, it seemed strongly probable that the larvæ of this beetle were responsible. During the following year Mr. C. F. Turner of the Bureau of Entomology found the larvæ responsible for this injury. He reared the adults and they proved to be the species suspected.

The nodules on the roots of this plant are very numerous and almost spherical. The larvæ are much more robust than those of *Cerotoma*, and they gnaw into one side of a nodule and out on the opposite side. All that is left of the nodule is a convex ring of epidermal tissue. When these injured nodules were first observed, practically all on the plants had been destroyed in this way. The larvæ probably feed on the roots as well.

Adults of this beetle have been taken during the winter hibernating in clumps of *Andropogon virginicus* and between the husks and under the leaf sheaths of standing corn stalks. The host plant does not appear above ground until May and adults have not been observed between the last of June and the middle of August. Adults were taken August 15 at Clarksdale, Miss.; August 23, at Elizabeth, Miss.; August 28, at Hardee, Miss., where they were found in copulo, and at West Memphis, Ark., September 23. There is probably but one generation a year in this region.

The beetle has been recorded as feeding on *Cassia occidentalis*, *C. obtusifolia*, *Sesbania vesicaria*, and on *Xanthoxylum clavaherculis* (see Pierce, W. D., "On the Biologies of the Rhynchophora of North America," University of Nebraska, 1907, pp. 256–257, and Mitchell, J. D., and Pierce, W. D., "The Weevils of Victoria County, Texas," Proc. Ent. Soc. Wash., Vol. 13, 1911, p. 50). Its principal hosts are thus seen to be legumes. While it is not known to damage cultivated species, the fact that it does defoliate *Xanthoxylum* would indicate that it is capable of varying its food plants. With the draining of the swamps and the decrease in its native hosts, it may some time become a pest, especially upon some of the introduced forage plants.

W. R. McConnell,
Bureau of Entomology.

Notes on Some Unusual Nursery Insects. *Pseudococcus kraunhiæ*[1] Kuwana (Homop.). This mealy bug was found during July, 1915, at Rutherford, N. J., on *Taxus cuspidata brevifolia* growing in a nursery. It had evidently been established for several years and only recently became abundant enough to cause noticeable injury. Mrs. Fernald, in her catalog of the "Coccidæ of the World," gives its habitat as Japan and host plant as *Kraunhia floribunda*. Some of the infested plants at Rutherford originally came from Japan.

Antonina crawi[1] Ckll. (Homop.). This insect, known as the cottony bamboo scale, was taken in considerable numbers at Riverton, N. J., August 6, 1915, on *Bambusa henonis* and *Bambusa aurea*, to which it was doing considerable damage by collecting in large colonies in the leaf axils of the young shoots or canes. This also is a Japanese species which occurs in California.

[1] Identified by Mr. Rust of the U. S. Bur. Ent.

Trioza magnoliæ Ashm. (Homop.). These "jumping plant lice" were exceptionally abundant on bay trees at Rutherford, N. J., during July, resulting in a deformation of almost every leaf on the trees. Tobacco extract and whale oil soap was found effective in controlling them.

Pteronus hudsonii Dyar (Hymen.). Larvæ of this saw-fly were found for the first time in New Jersey feeding on *Populus canadensis* at Rutherford and Trenton during the middle of August, 1915. The larvæ feed on the edges of the leaves and when disturbed thrash their abdomens about more or less violently.

Otiorhynchus sulcatus Fab. (Coleop.). This weevil, which is listed in Insects of New Jersey as occurring in different parts of the state, has recently become somewhat of a pest on rhododendrons and Taxus in several large nurseries. Dr. A. D. Hopkins gives the following interesting information about this species.

"*Otiorhynchus sulcatus* is a European species which has been established in this country a considerable number of years. In central Europe it is known according to Sorauer, to feed on grape vines, ground berries, peaches, flowers with juicy roots or root stalks, ferns and particularly Taxus and rhododendrons. It occurs there in light sandy or clay soils, in desert lands, meadows, forests, etc.; also in hothouses and manure piles. It seriously injures grapes by eating the leaves and buds in the spring. The principal damage is by the larvæ which seriously affect or even kill the stems. Their development is very uneven; normally the mature larva hibernates and pupates in the spring but also young larvæ from eggs laid late in the season hibernate and feed in the spring until pupation; some of the beetles issuing from the latter may again hibernate so that the same individual may hibernate twice. In general their seasonal history in this country is very similar to that of *O. ovatus*. Adults emerge from the soil during May, June and July and oviposit during June–August. The eggs are laid in the ground and the larvæ which hatch about two weeks later feed on the roots of their favorite plants. After hibernation they resume feeding in the spring and pupate in the soil during April and May. Trapping the adults by means of bundles of moss, leaves, straw, etc., placed on the ground in the evening and burned in the morning, is the most effective control method in Europe and likewise here. Advantage may also be taken of their habit to congregate in hiding during the day under boards and similar places." Dr. Hopkins advocates a thorough trial with tobacco dust for combating them after they are once in the ground. No determined effort has ever been made by New Jersey nurserymen to control this pest, it being considerably cheaper to sell the insects along with the plants.

HARRY B. WEISS, *New Brunswick, N. J.*

Sedentary Aphids vs. Spread of Fire Blight. In a recent number of *Phytopathology* I have tried to show that aphids are among the chief carriers of fire blight. An experiment seemed necessary at the time these tests were made to investigate the published statements that aphids are sedentary in habits while the Heteroptera so far studied on apple are not. If aphids are extremely sedentary, they can not rank as chief carriers. Let us see.

First, prolonged study showed that the six or seven different species of aphids, now reported on apple, are far from synchronous in their May to midsummer migrations. There is thus a nearly continual shifting of the aphis population, independent of enemies, interrupted only by each cooler weather period. Fire blight is likewise checked during the cooler periods of the growing season, but during optimum temperatures may be opportunely spread by aphids and leaf hoppers of one or the other shifting species.

Second, aphids are shown not to be sedentary with reference to a single shoot. An infested sprig of blighting crab was placed in a bottle of water in the laboratory.

The aphids slowly retreated downward to the cotton plug in the neck of the bottle where those which did not transform into winged aphids died, presumably from starvation. Under orchard conditions, such aphids should, in the light of the series of tests reported in *Phytopathology*, scatter blight to other shoots. It has since been observed in nature by Jones[1] who watched a colony of *A. pomi* vacate a blighting shoot, each individual descending to the base and going up fresh twigs. In thus scattering, they carried infection to seven surrounding clean shoots which blighted within a few days following their attacks. This may help explain the continued activity of blight in many trees where thorough pruning has been resorted to, and supports the view that aphids are among the chief carriers.

Third, intensive study of fertile stem mothers and later fall-bearing females shows that some mothers drop all their young in a very circumscribed area, on a given leaf or shoot, while others wander considerably before they are all through bearing young. Neither method of grouping young can be called unique for any particular species. Furthermore, injury to a young twig such as when blight attacks it, would produce some migration as shown by the above experiments. Under such conditions is it very important to consider the aphids as particularly sedentary?

Further observations on the habits of these aphids and other common Homoptera ought to be made before we may decide definitely which type of insect is most serious in the distribution of the germs of fire blight, after bees have stopped working in the blossoms.

A. C. Burrill,
Department of Economic Entomology, University of Wisconsin.

English Sparrows and Spread of San José Scale.[2] The English sparrow has been considered, with other wild birds, as carrier of the pernicious scale, but I am not aware that any very thorough study of the relative value of different birds as carriers has been made.

The following note compiled from a survey for the extermination of scale in Wingra Park, an isolated suburb of Madison, Wis., is a statistical attempt to produce further proof against the sparrow. The district surveyed was bounded on the south by a lake, on the east by a vacant marsh, on the north by a railroad cut and open lots, and on the west by farm fields, so that we may safely say that there was no possibility for the presence of scale within two or three city blocks of the surveyed infested area. In this circumscribed area we may suppose the English sparrow to be the only undomesticated bird species which would normally restrict its flight to so small an area, and serve as local carrier for short distances, since comparative psychologists consider the English sparrow very local in its habits of flight.

The area contained sixty-four infested city lots. In these lots all infested woody plants were either within one hundred feet of each other, or within one hundred feet of some place where English sparrows regularly came to feed. Places counted as English sparrow feeding centers were barns occupied by horses where grain feed was regularly exposed in manure piles, and chicken coops, where garbage and grain were regularly exposed.

The apparent relation between these feeding places and nearby woody plants is revealed by a study of the bird's habits. It is the habit of these birds, when coming towards feeding places, to fly into the branches of a woody plant to see that the

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[1] Jones, B. J. The natural modes of distribution of fire blight. Mo. Bul. State Com. Hort. Cal., 3, 12:505–11, 1914.

[2] Published with the permission of Prof. J. G. Sanders, Department of Economic Entomology, University of Wisconsin.

coast is clear, before descending to the ground to feed. In the same way, when they are suddenly disturbed, they fly back to an adjacent woody plant before going off, or returning to feed. Upon correlating this habit with the majority of infested plants I found that the infestations were not as near the main streets as they were to the alleys back of the lots, and that the feeding places—all barns, chicken coops and garbage—were invariably next the alleys.

The fact that these same feeding places are most often visited by human occupants of the land may be said to somewhat invalidate the theory that the sparrow is chief carrier. In rebuttal note that woody plants in the front yards and near the going and coming of the occcupants of the houses were less often infested. Thus human carriers and their most frequented routes did not usually coincide with the local infestation. This argues for considering birds and not men as the chief cause of infestation in the Wingra Park residence district of Madison.

Further details support the general conclusion. Of the several hundred city lots in Wingra Park, the tally of feeding places is as follows: three spots where garbage is openly scattered, but where chickens are not fed; forty-seven chicken coops and twenty-eight barns sheltering horses. The exact number within the general area of sixty-four infested lots is thirty chicken coops, and twenty-three barns, and all but three of these coops and one of the barns failed to have scale infestations within one hundred feet of them. Thus, about 90 per cent of the coops and barns within the infested area had scale located on nearby trees and shrubs, and about 85 per cent of the infested lots had sparrow feeding places on or next to them.

In some large trees only upper branches were infested, undoubtedly caused by perching birds. Sparrows regularly perch to bask in the sun when not feeding. Many of the infested trees and shrubs were in sunny, sheltered spots where sparrows regularly perch. The fact that twenty-two similar feeding points outside the exact infested area failed to show scale may be attributed to the hazards of chance and to the fact that sparrows fly short distances at any one time. Thus, if scale were on the birds when they retired to their nests, the scales would probably perish over night in hiding on the bird, in crawling off the bird and in wandering about the nest and eaves. No sparrow nests were noted in the trees, still further reducing the chances of scales to locate on host plants.

No native wild bird appears to have the exact feeding habits of the English sparrow, and, therefore, does not seem to fit the actual conditions of infestation as found. I should be glad to hear from other inspectors and entomologists if they differ from the way in which I have tried to apply the actual facts to the theory that English sparrows are chief carriers of scale in a closely settled residence district.

A. C. Burrill,
Department of Economic Entomology, University of Wisconsin.

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The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engraving, may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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The convincing or popular value of figures is well brought out in the article on estimating the number of grasshoppers. The man on the street has a liking for definite figures and the man on the farm is very like him in this respect. The successful entomologist must be enough of a psychologist to correctly estimate the value of various methods of presentation and it would seem that in some cases, at least, figures might be used a little more freely with great advantage. We do not mean by this, the more general employment of tables for the presentation of scientific data, useful though they may be, but the translation of familiar and vaguely appreciated infestations, for example, into definite, easily grasped mathematical equivalents. It would be even better, as suggested by this writer, if the hordes of insects could be valued in terms of produce necessary to their development.

It will be noted elsewhere in this issue that an entomologist holding an important position and apparently giving excellent satisfaction, has not been reappointed by a state executive. Knowing nothing of the details of the situation, we can only call attention to the well-known fact that uncertainty of tenure of office means a lowered efficiency in scientific work and especially is that true of a science dealing with such immense numbers of forms as are found among insects and which respond in so diverse ways to climatic and other influences. It should require little argument to demonstrate that a man with six years' experience in such a responsible position and meeting successfully its many and varied requirements would of necessity, in addition to prerequisite knowledge, possess a vast fund of practical experience of immeasurable value to the state which has profited by his services. If this is a removal on political grounds, then, we believe, the state has been unfortunate in the selection of its chief executive, and the continuance of such a policy means irreparable loss to the material interests of its citizens.

Current Notes

Conducted by the Associate Editor

Mr. C. A. Good has been appointed assistant entomologist at the Nova Scotia Agricultural College.

J. H. Fabre, the French entomologist, and the author of a number of popular books about insects, died October 11.

Messrs. Leroy Childs and G. F. Moznette have severed their connection with the Oregon Station, where they held positions as research assistants in entomology.

Mr. C. L. Scott, Bureau of Entomology, has been transferred from the Brownsville (Tex.) station to Wellington, Kan.

Mr. F. L. McDonough, Bureau of Entomology, was occupied during October in determining the limits of the dispersion of the boll weevil.

Dr. E. A. Back, Bureau of Entomology, in field charge of the Mediterranean fruit-fly investigations in Hawaii, has returned to Honolulu.

Mr. W. H. Larrimer, Bureau of Entomology, formerly located at the Wellington (Kan.) field station, has been detached and stationed temporarily at Missoula, Mont.

Mr. E. R. Barber, Bureau of Entomology, has returned to New Orleans after an extensive trip to determine the extent of the territory infested by the Argentine ant.

Mr. Harold Lyon, a graduate of the Massachusetts Agricultural College, class of 1913, is now studying at the Bussey Institution, Harvard University, Forest Hills, Mass.

Dr. E. A. Back, Bureau of Entomology, in charge of Mediterranean fruit-fly investigations in Hawaii, visited Washington on August 19 for consultation with reference to future work.

Professor H. F. Wilson of Oregon State College, has gone to the University of Wisconsin as professor of economic entomology to take the place of Professor J. G. Sanders.

Mr. R. J. Fiske, a graduate of the Massachusetts Agricultural College, class of 1910, is now engaged in codling moth investigations for the Bureau of Entomology at Roswell, N. M.

Mr. W. T. M. Forbes, a specialist in Lepidoptera, has been appointed to a position on the staff of the entomological department of the College of Agriculture of Cornell University.

Professor E. D. Sanderson is now a graduate student at the University of Chicago, where he expects to remain for two years or perhaps longer. His present address is 1109 East 54th Place.

Mr. J. R. Christie, formerly a student at the New Hampshire Agricultural College, is now instructor in zoölogy and entomology at the Maryland Agricultural College and assistant entomologist in the Station.

Mr. F. C. Bishopp, Bureau of Entomology, during the month of August investigated a serious outbreak of horse flies in Nevada and California upon which assistance had been asked by the Nevada Experiment Station.

Mr. Wallace L. Chandler, formerly of the University of California, has recently been called to Cornell University, where he will give instruction and conduct investigations in parasitology as a member of the entomological department.

Mr. F. A. Fenton, a graduate student of the University of Wisconsin, and for a time deputy nursery inspector in the same state, has joined the Federal Bureau of Entomology and will be engaged in work with Mr. J. J. Davis at Lafayette, Ind.

Mr. Henry L. Viereck is no longer connected with the California State Commission of Horticulture, where he has recently been assistant superintendent of the insectary at Capitol Park, Sacramento.

Mr. August Busck, Bureau of Entomology, has returned to Washington from the Hawaiian Islands where he carried on an investigation of *Gelechia gossypiella* for the Federal Horticultural Board.

Mr. Eric Cogan, Bureau of Entomology, temporarily employed at the Charleston (Mo.) field laboratory, has resumed his studies at Ohio State University. Mr. Cogan is specializing in Jassidea.

Miss Myrtle Duckett has been appointed a student assistant in the Bureau of Entomology to assist in recording the results of the wintering experiments in apiculture.

Mr. R. J. Kewley, Bureau of Entomology, recently attached to the staff at the La Fayette (Ind.) station, has been detailed to assist Mr. A. B. Gahan at College Park, Md.

Mr. E. W. Scott, Bureau of Entomology, employed in connection with the enforcement of the Insecticide Act, made a trip of investigation through Georgia and Florida during late October.

Dr. A. D. Hopkins returned to his office on October 27 from Kanawha Station, W. Va., where he was on leave and continued his observations on phenological phenomena, forest and wood-boring insects.

Mr. E. J. Newcomer, Bureau of Entomology, will spend the winter months at his permanent field quarters, Wenatchee, Wash., and will give attention to questions connected with the winter life of certain orchard pests.

Mr. John B. Gill, Bureau of Entomology, engaged in pecan insect investigations, has returned to his field headquarters, Monticello, Fla., from an extended trip through the Gulf States in connection with the study of pecan insects.

Mr. H. H. Kimball, Bureau of Entomology, who has been associated with D. L. Van Dine at Mound, La., will transfer his work to New Orleans where he will assist Dr. W. V. King in rearing Anopheles mosquitoes.

The Siamese grain beetle (*Lophocateres pusillus* Klug) has been reported by Prof. E. S. Tucker, at Baton Rouge, La., injuring rice. This species is not common in this country, but has been found in Texas, South Carolina, and received from foreign countries.

Mr. E. J. Branigan, field deputy of the California State Commission of Horticulture, is temporarily located at the Pasadena Station, Bureau of Entomology, distributing *Leptomastix* sp., a parasite of the citrus mealy bug (*Pseudococcus citri*). This parasite was recently introduced from Sicily.

Professor H. A. Ballou, Entomologist on the staff of the British Imperial Department of Agriculture, for several years stationed at Barbados, West Indies, is studying during his vacation at the Massachusetts Agricultural College, from which he graduated in 1895.

Mr. Alfred B. Champlain, assistant forest entomologist of the Bureau of Entomology, is now at Lyme, Conn., where he is making observations on the hickory bark beetle and other borers, and at the same time is receiving medical treatment for an ailment of the stomach.

Mr. Edward Riley King of Creola, Ohio, a former deputy state inspector of apiaries and secretary of the Ohio Beekeepers' Association, has been appointed a member of the teaching staff of the College of Agriculture of Cornell University, where he will conduct the new courses in apiculture.

Mr. F. B. Paddock has been appointed entomologist in charge at the Texas Agricultural Experiment Station and State Entomologist to succeed Mr. Wilmon Newell who has gone to Florida as State Plant Commissioner. By virtue of law the state entomologist is in charge of the foul brood eradication work.

At the New Hampshire College, Mr. W. A. Osgood, class of 1915, has been appointed assistant to Professor W. C. O'Kane and will be engaged in state work. He began his duties September 1. Mr. Raymond Bean, class of 1915, has been appointed assistant to Professor C. F. Jackson in the department of zoölogy.

In connection with the wintering investigations at the apiary of the Bureau of Entomology, tests are now being made of the thermal conductivity of various double-walled hives and of the coefficient of transmission of heat of the various parts of the hive to determine the best methods for constructing such hives.

Mr. David L. Crawford, formerly entomologist and horticulturist for the Mexico Gulf Coast Citrus Association, Tampico, Mex., has submitted for publication, in the Department of Agriculture, a manuscript on the Mexican orange fly, *Anastrepha ludens* Loew.

The Bureau of Entomology has received from Mr. C. F. Stahl, Spreckels, Cal., a sample of walnuts badly infested by the Mediterranean flour moth, *Ephestia kuehniella*. These were obtained in October of the present year. It also occurs in peanuts in the East.

Mr. H. B. Scammell, Bureau of Entomology, will spend the winter at his field station, Brown Mills, N. J., and will give special attention to questions connected with the hibernation of cranberry insects. Mr. R. J. Fiske will also spend the winter at his field headquarters, Roswell, N. Mex.

Mr. T. C. Barber, Bureau of Entomology, delivered a number of addresses on the boll weevil in Georgia during October. This work was a part of the plan of the Georgia State Board of Entomology to give special instructions to the planters in the districts which have recently become invaded by the boll weevil.

Mr. H. A. Morgan, director of the Tennessee Experiment Station, recently visited Louisiana, in company with Dr. W. D. Hunter of the Bureau of Entomology, for the purpose of making suggestions regarding the conduct of the boll-weevil work, and the work on malaria mosquitoes.

At the Kansas College and Station, Dr. Paul S. Welch, who has been engaged in the investigation of staple crop insects for the Station, is now giving his entire time to college work as assistant professor of entomology. Mr. W. P. Hayes has been added to the station staff as assistant in entomology, and will investigate the insects attacking staple crops.

Mr. Frank N. Wallace has been appointed State Entomologist of Indiana to succeed Charles H. Baldwin. Mr. Wallace was Chief Deputy under Benjamin W. Douglass, who was State Entomologist of Indiana from 1907 to 1911. During the past four years Mr. Wallace has been engaged in horticultural consultation work and has been called to orchards in many parts of the country.

Mr. A. C. Baker, Bureau of Entomology, has reported for permanent duty in Washington and will be engaged in systematic studies of the Aphididæ and Aleyrodidæ. The biological studies of orchard plant lice in progress at the Vienna (Va.) laboratory will, however, be continued by Messrs. A. C. Baker and W. F. Turner, Mr. Turner remaining at the laboratory at Vienna.

Mr. E. G. Carr, Bureau of Entomology, spent the month of October in the mountain section of North Carolina and reports that beekeeping is not well developed there but that there is a wonderful opportunity for making it an important phase of agriculture since there is an abundance of nectar and plenty of bees to gather it if properly cared for.

Mr. R. S. Woglum, Bureau of Entomology, recently visited San Diego, Cal., for the purpose of investigating a species of *Pleliobius* injuring olive. This olive insect was found to be established in various sections of San Diego County. Breeding occurs only in the dead wood. However, the adults cause considerable injury to living trees, especially to the smaller twigs, by boring into and feeding on the bark.

Among insects which have been reported as causing injury during the year are the spotted cutworm (*Noctua c-nigrum L.*) and the variegated cutworm (*Peridroma margaritosa* Haw.). The last-mentioned species was especially numerous and was reported as occurring in Brownsville, Tex., where it was injurious to onions, and found commonly on weeds and grasses; also along the coast of California and at Norfolk, Va.

Dr. E. F. Phillips made plans to leave about November 20 to attend meetings of beekeepers in Ontario, Ohio, Chicago and Springfield, Ill., Kansas, Minnesota, Wisconsin, Indiana, Iowa and Michigan. This circuit of meetings was arranged to make it easier for those interested to attend. The meeting at Grand Rapids, Mich., is the fiftieth convention of the Michigan society and elaborate preparations are being made for it.

Among the visitors at the Bureau of Entomology during October were the following: C. P. Lounsbury, chief of the Division of Entomology of the Union Department of Agriculture, South Africa; H. A. Ballou, entomologist on the staff of the Imperial Department of Agriculture for the West Indies; C. W. Leng, New York; W. T. Davis, Brooklyn; W. S. Blatchley, Indianapolis; J. v. d. H. Schreuder, Pretoria, South Africa.

Mr. F. R. Cole reports to the Bureau of Entomology that the tachinid parasite, *Siphona plusiæ* Coq., has been reared from the cabbage looper (*Autographa brassicæ*) from Whittier, Pasadena and Compton, Cal., the last locality being furnished by Mr. J. E. Graf. This species was described from *Autographa californica* Speyer from Southern California. Another parasite attacks this species but it has not been reared or identified as yet.

Dr. Alden T. Speare has recently been appointed a specialist in insect diseases in the Bureau of Entomology and will make a thorough study of entomogenous fungi, with a view to their practical utilization if possible in insect control. He will be glad to receive specimens of diseased insects from all sources, and the material should be accompanied with full data as to the host-species, extent of outbreak of the disease, locality, etc.

According to press reports, Professor Gordon M. Bentley, State Entomologist of Tennessee, has not been reappointed. The following excerpt is from *The Southern Florist* for October: "Despite the petitions and urgent requests of fruit growers,

nurserymen, farmers and business men generally Governor Rye, through the new commissioner of agriculture, refused to reappoint Prof. Gordon M. Bentley to the important position of state entomologist of Tennessee."

The office of State Entomologist has recently been established in Wisconsin, to take over the nursery and orchard inspection and administration of the laws governing insecticides and fungicides. It is to be independent of the University of Wisconsin, with headquarters in the State Capitol at Madison. Professor J. G. Sanders comes from the College of Agriculture to be the first incumbent of the office and Dr. S. B. Fracker, an instructor in the same department, has been appointed assistant entomologist.

The spinach leaf-miner (*Pegomyia vicina* Lintn.) has been reported as injuring garden beets during June and July at Green Bay, Wis., by Mr. N. F. Howard, working temporarily for the Bureau of Entomology. It has also been reported injuring spinach at Woods Holl, Mass., the correspondent stating that after the spinach was boiled the little white maggots could be seen on the surface. It may be remembered that those who have tried kerosene emulsion for the insect as it occurs in the mines have obtained no results.

Some interesting species of insects injurious to stored products have recently been collected. One is the broadheaded flour beetle (*Latheticus oryzæ* Waterh.), reported by Mr. F. B. Milliken in two mills at Wichita, Kans. The files of the Bureau of Entomology show that this species was also reported at Wichita Falls, Tex., in 1909, and at Lyons, Kans., in July, 1908. It is common in Texas, and has only in recent years spread widely to other regions; for example, to Baton Rouge, La., Elizabethtown, Ill., and Detroit, Mich.

The semitropical army worm (*Prodenia eridania* Cram.) has been reported, with accompanying specimens, as being injurious at Hastings, Fla. This army worm appeared in a field of cowpeas, traveled to a field of sweet potatoes, and crossed a ditch by means of overhanging weeds into another field of cowpeas and corn. It was impossible to spray the cowpeas and corn, but the correspondent stated that he could save the sweet potatoes by other treatment. Several other reports have been made of an insect which is probably this species, though it has not been positively identified.

Mr. T. E. Snyder, Bureau of Entomology, left on October 23 for a ten-day trip to Savannah, Ga., Virginia and Tennessee. At Savannah he inspected treated telephone poles for resistance to insect attack. This work is being done in coöperation with the American Telegraph and Telephone Company. In the latter states he inspected the control work against the southern pine beetle by the Forest Service in the White Top Purchase Area and to mark newly infested trees for further control work.

The fifty-second annual meeting of the Entomological Society of Ontario was held at Ottawa, November 4 and 5 under the presidency of Dr. C. Gordon Hewitt, the Government Entomologist. The program was varied and most interesting, and the meeting was very successful, a goodly number being in attendance. Dr. H. T. Fernald gave an illustrated lecture on: "Life Zones in Entomology and their Relation to Crops." There were a number of economic papers, one of the more interesting dealing with the extraordinary outbreak of *Lygus invitus* by W. Brittain. A full account of this meeting will appear in the annual report of the Society, a publication well and favorably known to American entomologists.

Dr. E. F. Phillips, Bureau of Entomology, attended a meeting of the farm demonstrators of North Carolina at Raleigh on August 21 and 23 for the purpose of arranging for a new line of work soon to be undertaken. It is planned to make a survey of the state for the purpose of determining the possibilities of building up beekeeping and to test out, in coöperation with the county agents, various lines of extension work. E. G. Carr, deputy state apiary inspector for New Jersey and a director of the National Beekeepers' Association, has been appointed to do the field work on this project and will begin work on October 1. Mr. Carr has had extensive experience as a practical beekeeper and has served as inspector for several years.

Mr. J. R. Horton, Bureau of Entomology, in field charge of the citrus fruit insect investigations in Louisiana, recently submitted an account of the hurricane which passed through southern Louisiana on September 29. He reports that in an experimental orchard at Venice fully 95 per cent of the oranges were blown off the trees, many of them being carried considerable distance. Orange trees were literally whipped to pieces and the foliage discolored, as though scorched by fire. Practically all of the ant traps and fumigation covers at Happy Jack were destroyed. Many lights were broken out of the laboratory windows in New Orleans, and one chimney was blown down. A large percentage of the cages used in fig-borer experiments were blown over, and many of the specimens disappeared. Mr. Horton left New Orleans on September 28, and was at a point near Doullutt's Canal, which was in the worst section of the storm.

Recently two new wire cages have been added to the Eastern Field Station of the Bureau of Entomology at East Falls Church, Va. Both of these consist of a temporary framework with a concrete foundation and covered with a lattice roof and completely screened in with 14-mesh galvanized screen wire. One of these is to be used for experiments dealing with insects injurious to crude forest products and the study of the life history of various secondary insects. The other one is to be used for life-history studies of the introduced *Evetria buoliana* and *Diprion simile*. In constructing this cage great care has been used. It is to be double-walled and to have a vestibule entrance. Every possible precaution has been taken in building this cage because of the danger of liberating specimens of these injurious forest insects. In this cage it is planned to grow various species of pines which may serve as hosts of the two imported species. The experiments are to be conducted entirely on growing trees and under conditions which very closely approximate those found in nurseries and forests.

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TWENTY-EIGHTH ANNUAL MEETING OF THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Columbus, Ohio, December 27 to 30, 1915

The twenty-eighth annual meeting of the American Association of Economic Entomologists will be held at the Ohio State University, Columbus, Ohio, beginning December 27 and ending December 30, 1915. The meetings will be held in Botany and Zoölogy Hall in that institution.

The opening session will begin at 1.30 p. m., Monday, December 27. The annual reports and reports of committees will be presented then and the address of the president delivered. The meeting of the general association will be continued on Tuesday, at 10.00 a. m., 1.30 p. m. and on Wednesday at 1.30 p. m. The final session will be held on Thursday at 10.00 a. m.

Sectional Meetings

The meeting of the section on Apiary Inspection will be held at 8.00 p. m. Monday, December 27, at which time the regular business of the section will be transacted and a program of papers presented. The meeting of the section on Horticultural Inspection will be held Tuesday at 8.00 p. m. and Wednesday at 10.00 a. m.

Other Meetings

The American Association for the Advancement of Science and its affiliated societies will hold meetings throughout the week. The meeting of the Entomological Society of America will begin on Wednesday, December 29, and continue on Thursday and possibly on Friday. The public lecture before that society will be delivered on Wednesday evening, December 29, by Dr. C. Gordon Hewitt, Entomologist of the Dominion of Canada. A meeting of the instructors and investigators in apiculture will be held on Tuesday morning, December 28.

Smoker

The entomologists of Ohio will tender all visiting entomologists a smoker which will be held on Wednesday evening immediately after the public address.

Hotel Headquarters

The hotel headquarters of this Association has been selected at the Southern Hotel, South High Street, from which cars run direct to the Union Station and to the university. The rates for rooms, European plan, are as follows: single rooms, without bath, $1.50 per day; double rooms, without bath, $2.50 and up per day; single rooms, with bath, $2.00 per day; double rooms with bath, $3.50 and up per day. As there will be a large attendance at the meeting, rooms should be engaged well in advance.

Railroad Rates

The exact data on railroad rates are not available. Members should consult their local ticket agents or agents in the nearest large cities where reductions in rates are likely to apply. Information can undoubtedly be secured from the regular announcement of the meeting of the American Association for the Advancement of Science.

Official Buttons

Official buttons of the Association will be furnished to members whose dues for 1916 are paid. Application for buttons should be made to the Secretary at the time of the meeting.

Membership

Application blanks for membership may be secured from the Secretary or from members of the committee on membership.

Program

Monday, December 27, 1915, 1.30 p. m.

Report of the Secretary.

Report of executive committee, by President Glenn W. Herrick.

Report of employment bureau, by W. E. Hinds, Auburn, Ala.

Report of committee on nomenclature, by Herbert Osborn, Columbus, Ohio.

Report of committee on entomological investigations, by W. E. Hinds, Auburn, Ala.

Report of committee on bibliography of economic entomology by E. P. Felt, Albany, N. Y.

Appointment of committees.

Miscellaneous business.

Action on the following proposed amendment to the constitution;

Section I, Article III, insert the words "branch or" before the word "section" in line two so that the first sentence of Section I will read as follows: "The officers shall consist of a president, one vice-president and an additional vice-president for each branch or section who shall be elected annually, and a secretary who shall be elected for a term of three years, who shall perform the duties customarily incumbent upon their respective offices and as defined in the by-laws."

Action on the following proposed amendment to the by-laws:

Add a new section to Article II as follows: "Section IV. The publication of the JOURNAL OF ECONOMIC ENTOMOLOGY shall be entrusted to an editor, an associate editor and a business manager nominated by an advisory committee of six members which latter shall be elected for terms of three years so arranged that two shall be elected annually. The members of this committee shall have an advisory relation to the above constituted editorial board."

New business.

Annual address of the President, Glenn W. Herrick, Ithaca, N. Y., "The Need of a Broad, Liberal Training for the Economic Entomologist."

READING OF PAPERS

"Further Notes on *Diprion simile* Hartig," by W. E. Britton, New Haven, Conn. (5 minutes.)

Notes on the distribution, injury, number of generations and parasites of this European sawfly in Connecticut.

"A Preliminary Report on the Life Economy of *Solenopsis molesta* Say," by J. W. McColloch, Manhattan, Kans. (12 minutes.)

This paper will present the data thus far obtained on the life history of the kafir ant.

"Some Insects of *Solanum carolinense* L., and their Economic Relations," by M. P. Somes, Mountain Grove, Mo. (10 minutes.)

A review of life history of certain insects found on this weed and their development when transferred to related economic plants.

"Concerning Problems in Aphid Ecology," by Edith M. Patch, Orono, Me. (15 minutes.)

An outline indicating certain phases of aphid study with especial reference to life cycle work with migratory species.

"Life History Notes on *Apeteticus cynicus* and *maculiventris*," by R. D. Whitmarsh, Wooster, Ohio. (3 minutes.)

"Distribution of Periodical Cicada in Ohio for the years 1906, 1914 and 1915," by H. A. Gossard, Wooster, Ohio. (5 minutes.) Lantern.

Maps of the areas in which they appeared and remarks thereon.

"Honey as a Carrier of Pear Blight Germs," by H. A. Gossard, Wooster, Ohio. (10 minutes.) Lantern.

Adjournment.

SECTION OF APIARY INSPECTION

E. F. PHILLIPS, *Chairman.* N. E. SHAW, *Secretary.*

Program

Monday, December 27, 8.00 p. m.

Address by the Chairman, E. F. Phillips, Washington, D. C.

READING OF PAPERS AND DISCUSSIONS

"The Desirability of Inspection Work from the Standpoint of Queen Breeders," by E. R. Root, Medina, Ohio.

"Some Difficulties in Cross Diagnosis of Disease," by A. H. McCray, Washington, D. C.

"Outline of Apiary Inspection in Ontario," by Morely Pettit, Guelph, Ontario.

"Suggestions for Efficiency and Economy in Apiary Inspection Service," by H. A. Surface, Harrisburg, Penn.

Adjournment.

Program

Tuesday, December 28, 10.00 a. m.

Discussion of the Presidential Address.

Reading of Papers

"The Columbine Leaf Miner," by E. N. Cory, College Park, Md. (10 minutes.)

Life and seasonal history. Control.

"Observations on the Turnip Louse," by F. B. Paddock, College Station, Texas. (15 minutes.)

Bionomical observations made upon this insect in Texas during two years' study of the pest.

"Fumigation of Animals to Destroy their External Parasites," by William Moore, University Farm, St. Paul, Minn. (15 minutes.)

An account of a new material which can be used to fumigate animals and destroy their parasites without injury to the animal.

"The Clover Leaf Tyer, *Ancylis angulifasciana*," by H. A. Gossard, Wooster, Ohio. (7 minutes.) Lantern.

Life history, character of damage and control.

"*Dasyneura ulmea* Felt, an Elm Pest," by J. S. Houser, Wooster, Ohio. (5 minutes.) Lantern.

Causes malformations on the terminal twigs of elm.

Adjournment.

Program

Tuesday, December 28, 1.30 p. m.

Reading of Papers

"A New Method of Subterranean Fumigation," by J. S. Houser, Wooster, Ohio. (12 minutes.) Lantern.

"Sulphur-Arsenical Dusts Against the Strawberry Weevil," by T. J. Headlee, New Brunswick, N. J. (15 minutes.) Lantern.

Among the fifteen different treatments given the plants just as the weevils begin their work; the sulphur arsenical dusts gave the best results and afforded a high degree of protection.

"The Effect of Contact Insecticides on the Larvæ of Syrphidæ, by C. L. Metcalf, Columbus, Ohio. (7 minutes.)

"The Accurate Determination of the Nicotine Content of Spraying Solutions," by V. I. Safro, Louisville, Ky. (15 minutes.)

"Arsenic on Fruit and Forage Following Spraying," by Walter C. O'Kane, Durham, N. H. (15 minutes.) Lantern.

Sheep poisoning; Loss of lead arsenate residues on hay; maximum residues on fruit; conclusions as to factors determining amount of residues.

"The Control of the Grape Berry Worm, *Polychrosis viteana*," by W. H. Goodwin, Wooster, Ohio. (10 minutes.) Lantern.

This paper deals with the life history in northern Ohio and the development of control methods for the berry worm.

"Notes on the Control of the Lesser Peach-tree Borer," by J. L. King, Cleveland, Ohio. (15 minutes.) Lantern.

Cultural methods such as pruning and cultivation; also time to "worm the trees."

"Climate and Variations in the Habits of the Codling Moth," by E. P. Felt, Albany, N. Y. (10 minutes.)

This paper is concerned chiefly in recording variations observed in New York State and attempts to explain these by local variations in temperature.

"Life History of the Pecan Twig Girdler," by S. W. Bilsing, College Station, Texas. (15 minutes.) Lantern.

The life history of the pecan twig girdler (*Oncideres texana*); methods of control; injury done; food plants, etc.

Adjournment.

SECTION OF HORTICULTURAL INSPECTION

W. E. RUMSEY, *Chairman.* J. G. SANDERS, *Secretary.*

Program

Tuesday, December 26, 8.00 p. m.

(Detailed program of this section will be available at the meeting.)

Wednesday, December 29, 10.00 a. m.

(Detailed program will be available at the meeting.)

AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Program

Wednesday, December 29, 1.30 p. m.

READING OF PAPERS

"Notes on Crambidæ," by George G. Ainslie, Nashville, Tenn. (5 minutes.)

A brief outline of the economic significance of Crambidæ and notes on the work carried on at Nashville.

"A Study of the Life History of the Maize Bill Bug," by Wm. P. Hayes, Manhattan, Kans. (12 minutes.) Lantern.

Distribution in Kansas, economic importance, life history and habits, and methods of control.

"The Small Pink Corn Worm, *Batrachedra rileyi*, in Mississippi," by R. W. Harned, Agricultural College, Miss. (5 minutes.)

Brief notes on occurrence of this insect in Mississippi. It must be ranked as a pest of considerable importance.

"The Economic Status of the Seed Corn Maggot, *Pegomyia fusciceps*," by W. J. Schœne, Blacksburg, Va. (8 minutes.)

A discussion of the food plants and the condition of the food attacked.

"Records of Lachnosterna in Wisconsin," by J. G. Sanders, Madison, Wis. (15 minutes.) Lantern.

Report on the results of using trap lanterns for capturing May beetles.

"A Progress Report on White Grub Investigations," by John J. Davis, West Lafayette, Ind. (10 minutes.)

Summary of Lachnosterna investigations to date.

"Notes on Pegomyia hyoscyami Panz.," by E. N. Cory, College Park, Md. (10 minutes.)

Life and seasonal history.

"Notes on the Biology of *Pegomyia brassicæ* Bouche," by W. J. Schœne, Blacksburg, Va. (10 minutes.)

A presentation of the more important observations on the life history of the species.

"An Investigation of the Supposed Immunity of Some Varieties of Wheat to the Attack of Hessian Fly," by L. Haseman, Columbia, Mo. (15 minutes.)

A brief summary of the first year's work, including data collected from plots of different varieties of wheat grown side by side, together with notes on some chemical and physiological variations in the different varieties.

"The Hessian Fly Train," by George A. Dean, Manhattan, Kans. (12 minutes.) Lantern.

A brief account of the Hessian fly infestation in the state; the organization of the special train; how the train was conducted and the results accomplished.

"County Coöperation to Prevent Hessian Fly Damage," by H. A. Gossard, Wooster, Ohio. (5 minutes.)

This paper describes a method by which an entire county was kept solidly in line, almost no one sowing until advised by the county agent and Station Entomologist to do so.

Adjournment.

Program

Thursday, December 30, 10.00 a. m.

Reading of Papers

"Dispersion of *Musca domestica* Linnæus under City Conditions," by Ralph R. Parker, Bozeman, Mont. (15 minutes.) Lantern.

An account of dispersion experiments conducted on a large scale.

"An Appreciation of the Hawaiian Parasite Introduction Work," by L. O. Howard, Washington, D. C. (15 minutes.) Lantern.

A brief account of observations made and facts learned on a visit to Oahu in August, 1915—an effort to show more emphatically than has hitherto been done, the importance of the results accomplished.

"Life History and Habits of Two New Nematodes Parasitic on Insects," by Joseph H. Merrill, Manhattan, Kans. (12 minutes.)

One of these nematodes is parasitic upon *Saperda tridentata* and the other upon *Leucotermes lucifigus*.

"Some Non-bacterial Insect Diseases," by J. W. Chapman, and R. W. Glaser, Forest Hills, Mass. (15 minutes.) Lantern.

Methods of diagnosis, distribution and etiological investigations.

Final Business

Report of committee on auditing.
Report of committee on resolutions.
Report of committee on membership.
Report of other committees.
Nomination of Journal Officers by Advisory Committee.
Report of committee on nominations.
Election of officers.
Miscellaneous business.
Fixing the time and place of next meeting.
Final adjournment.

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Glenn W. Herrick, *President*,
Ithaca, N. Y.

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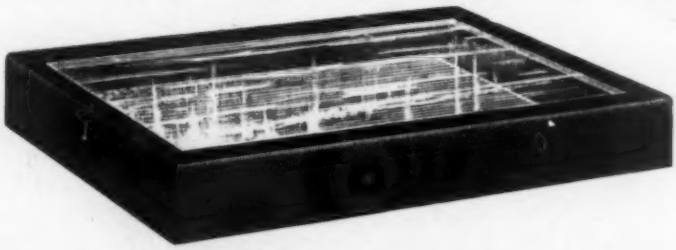

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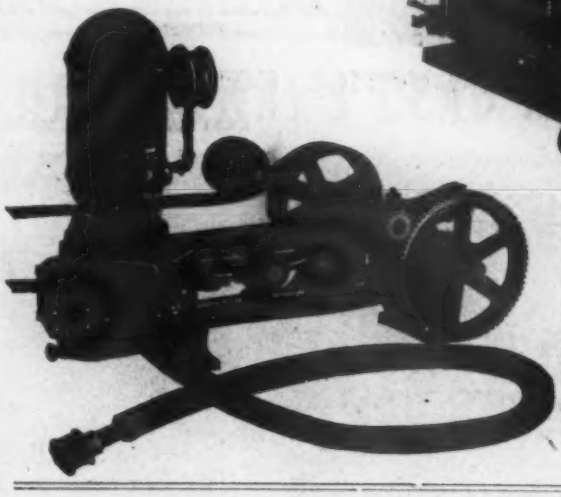

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A. G. BAGSHAWE, M. B., D. P. H. Cantab.

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